केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

भारत सरकार

Central Ground Water Board

Ministry of Water Resources, River Development and Ganga Rejuvenation

Government of India

Report

on

AQUIFER MAPPING

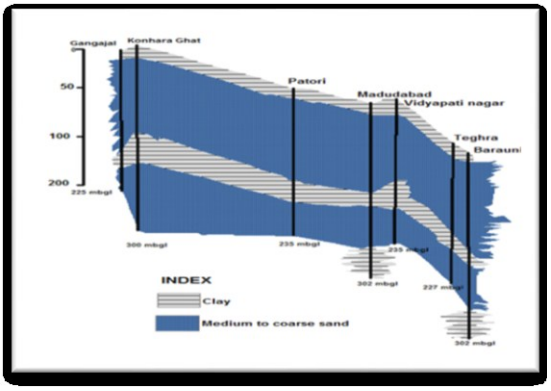
Parts of Saran, Vaishali, Samastipur, Begusarai and Patna Districts, Bihar

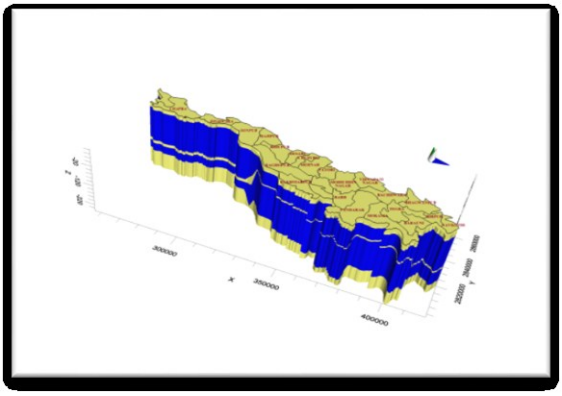
मध्य पूर्वी क्षेत्र, पटना

Mid-eastern Region, Patna

Report
on

Aquifer Mapping in parts of Saran, Vaishali, Samastipur, Begusarai and Patna distrcits, Bihar (NAQUIM_Phase-II)





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CENTRAL GROUND WATER BOARD
MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION

GOVERNMENT OF INDIA
MID EASTERN REGION, PATNA
July 2016

Report
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Aquifer Mapping in parts of Saran, Vaishali, Samastipur, Begusarai and Patna distrcits, Bihar (NAQUIM_Phase-II)

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Aquifer Mapping in parts of Saran, Vaishali, Samastipur, Begusarai and Patna distrcits, Bihar (NAQUIM_Phase-II)

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CHAPTER- 1
INTRODUCTION

Under the phase II of National Aquifer Mapping programme (NAM), a total of 23 blocks falling in Patna, Saran, Vaishali, Samastipur and Begusarai distrcits have been taken up for detailed hydrogeological survey and preparation of Aquifer Management plan. In the study, hydrogeological survey, geophysical investigations and groundwater quality studies have been undertaken and the data generated have been used in conjunction with the existing data available for the area in preparation of the aquifer maps and formulation of the aquifer management plan.

In addition to the 23 blocks, the present report also documents the findings of the investigations done in Ravelganj and Chapra Blocks covered during Phase I.

1.1 Objective and Scope

The project envisages detailed characterisation of the aquifers by integarating the available data pertaining to lithology, groundwater geophysics, groundwater quality with the newly generated data during the course of National Aquifer Mapping programme. The generation of the fresh data under the NAQUIM has been made on the basis of the data gaps identified. Phase wise national Aquifer Mapping area are given in Fig. 1.1

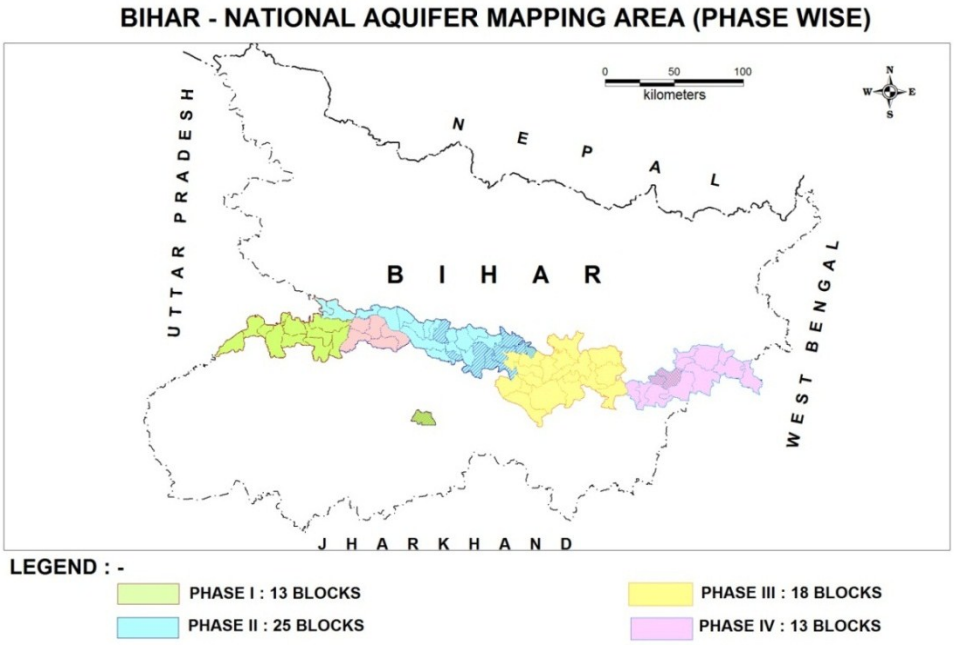


Fig. 1.1 Area to be covered under NAQUIM in different phases

Attempt has also been made to generate a conceptual model of the area for depicting the aquifer in 3-D using visual Modflow pro software. Village map of phse II are given in Fig 1.2.

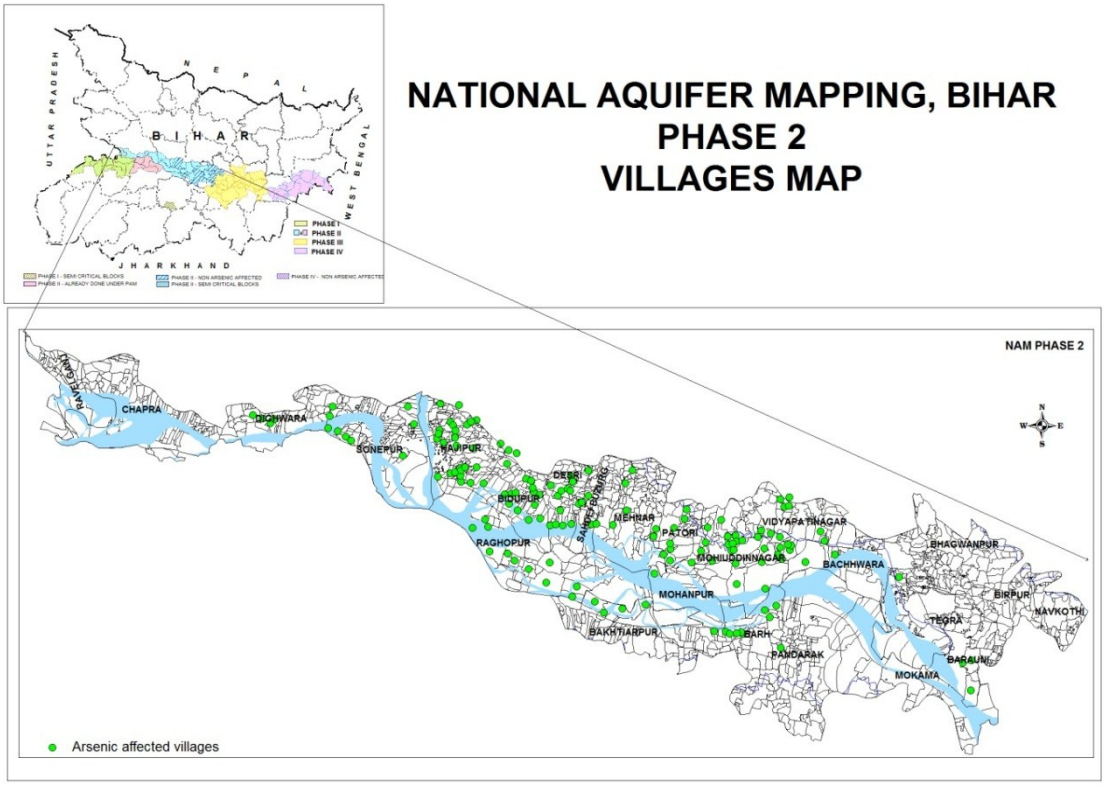


Fig. 1.2 Villages map of NAQUIM Phase- II

1.2 Approach and Methodology

The work plan for the aquifer mapping envisaged compilation, integration, validation and analysis of the existing database at one platform with a view to generate various thematic maps like land use and land cover map, geomorphology maps, geology, hydrogeology etc using various GIS and geo-scientific computer softwares. Data were collected from all concerned agencies for preparing the status of data gap. Greater attention was paid on activities that required generation of additional data to fill the identified gap.

1.3 Area Details

The area falling under Phase II of NAM in Bihar State covers the aquifers in the Ganga stem part and spreads over the Saran, Vaishali, Samastipur and Begusarai located on the northern bank of the Ganges and the eastern parts of the Patna district on the southern bank of the Ganga. A total of 23 blocks have been covered during this phase.

The study area spreads over 2678 Sq Kms covering 23 administrative blocks. The area lies between N latitudes 25.851 and 25.491 and E longitudes 84.573 and 86.197 falling in Survey of India toposheet nos 72C/9, 10, 13, 14, 72G/2, 5, 6, 7, 10, 11, 14, 15 and 72K/2, 3 . The location of the study area is shown in Fig. 1.3. The population density of the study area is 289 person per sq. km. The salient demographic details of the administrative blocks falling in the area is given in Table 1.1.

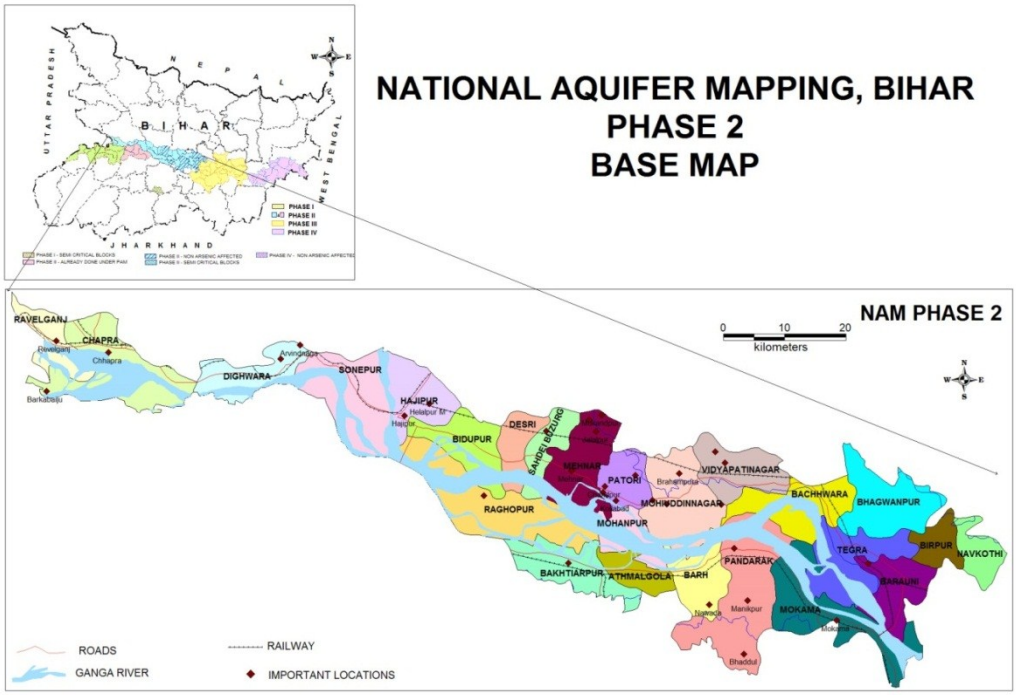


Fig.1.3: Base map of the Study area

Table 1.1: Demographic details of the administrative blocks falling under National Aquifer Mapping area – Phase 2

S. No.	Block	TotalArea (in Sq.Km.)	Population (as per 2011 census)		
			Rural	Urban	Total
1	Ravelganj	74	12460	6016	18476
2	Chapra	201	35998	33303	69301
3	Dighwara	98	15425	5237	20662
4	Sonepur	182	37472	6383	43855
5	Mokama	177	22873	10544	33417
6	Hajipur	112	50867	24033	74900
7	Raghopur	234	40183	0	40183
8	Bidupur	108	45287	0	45287
9	Desri	62	15450	0	15450
10	Sahdai Buzurg	64	23958	0	23958

11	Mahnar	139	24107	7908	32015
12	Patori	68	32606	0	32606
13	Mohanpur	70	21114	0	21114
14	Mohiuddinagar	160	35885	0	35885
15	Vidyapati Nagar	108	29982	0	29982
16	Bhagwanpur	142	35035	0	35035
17	Bachhwara	125	39641	0	39641
18	Teghra	139	26213	23736	49949
19	Barauni	102	35436	16633	52069
20	Birpur	51	18832	0	18832
21	Naokothi	56	22655	0	22655
22	Bakhtiarpur	115	27240	7295	34535
23	Athmalgola	54	13681	0	13681
24	Barh	97	23780	9310	33090
25	Pandarak	241	23968	0	23968

1.4 Brief Description

The phase 2 area of Bihar stretches from Saran in west to Begusarai in east covering parts of five districts and 23 blocks. The phase 2 area is traversed by approximately 172 km long stretch of river Ganga forming the axial drainage**.** The area is characterised by highly fertile alluvial plain. The soil type is loamy to coarse grained. During heavy monsoons, part of the area on the southern bank of the river Ganga gets flooded and remains water logged for months, locally called as *tal* areas.

1.4.1 Data availability

Central Ground Water Board has carried out hydrogeological surveys and groundwater exploration in the area. Ground water regime monitoring is carried out on a regular basis. The data available from the earlier surveys have been compiled and data gap analysis has been carried out for working out the need for additional data generation in the study area.

1.*4*.2 Data adequacy and data gap analysis and data generation

As per the existing data availability on April 2012, data gap analysis was done. On the basis of this data gap analysis, fresh data was generated. All the data gap analysis is done on the basis of area of the blocks under study. Some of the requirement in the area has been reworked considereing homogeneity in aquifers for fresh data to be generated *(Table. 1.2, 1.3, 1.4)*.

Table 1.2: Water level monitoring data of Phase- II

S. No.	State	District	Block	Requirement reworked considering homogeneity in aquifers	Data availbility	Data Gap	Data Generated
1.	Bihar	Patna	Bakhtiarpur Barh Athmalgola Pandarak Mokama	13	2	11	11
2.	Bihar	Vaishali	Hajipur Raghopur Bidupur Desri Sahdei Buzurg Mehnar	18	2	16	16
3.	Bihar	Saran	Dighwara Sonepur Chapra Ravelganj	21	8	13	13
4.	Bihar	Samastipur	Mohanpur Patori Mohiuddinnagar Vidyapatinagar	17	3	14	14
5.	Bihar	Begusarai	Bachhwara Naokothi Barauni Teghra Bhagwanpur Birpur	16	4	12	12

Table 1.3 : Groundwater quality data of Phase-II

S. No.	State	District	Block	Requirement reworked considering homogeneity in aquifers	Data Availability	Data Gap	Data Generated
1.	Bihar	Patna	Bakhtiarpur Barh Athmalgola Pandarak Mokama	49	18	31	31
2.	Bihar	Vaishali	Hajipur Raghopur Bidupur Desri Sahdei Buzurg Mehnar	15	10	5	5

3.	Bihar	Saran	Dighwara Sonepur Chapra Ravelganj	8	3	5	5
4.	Bihar	Samastipur	Mohanpur Patori Mohiuddinnagar Vidyapatinagar	5	5		
5.	Bihar	Begusarai	Bachhwara Naokothi Barauni Teghra Bhagwanpur Birpur	41	7	34	34

Table 1.4: Geophysical data (VES) of Phase-II

S. No.	State	District	Block	Reqt. prospect as per area of block	Data Availability	Data Gap	Data Generated
1	Bihar	Patna	Bakhtiarpur Barh Athmalgola Pandarak Mokama	29	24	5	5
2	Bihar	Vaishali	Hajipur Raghopur Bidupur Desri Sahdei Buzurg Mehnar	69	25	44	44
3	Bihar	Saran	Dighwara Sonepur Chapra Ravelganj	34	20	14	14
4	Bihar	Samastipur	Mohanpur Patori Mohiuddinnagar Vidyapatinagar	23	15	8	8
5	Bihar	Begusarai	Bachhwara Naokothi Barauni Teghra Bhagwanpur Birpur	22	22		

1.4.3 Rainfall-spatial and temporal distribution

The area experiences a humid sub-tropical climate. The monsoon season intiates by the third week of June and continues till the end of September. There is slight rainfall in

October but November and December are quite dry. The rainy season receives Southwest monsoon and accounts for about 90% of the total rainfall. The area receives an average normal monsoon rainfall of about ~ 1100 mm/year.

1.4.4 Physiographic setup

The area under NAQUIM Phase 2 covers central part of Bihar State. The area comprises of fertile alluvial plains separated in two parts north and south by river Ganga. The surface for the part located on the northern bank of the River Gnaga shows a general slope towards the south-east while for the part located on the southern flank of the Ganges, the general slope is towards north-east. The area has a major part as islands in the course of Ganga river, locally called as *Diyaras*. These diyaras comprises of some of the blocks of phase 2 such as Raghopur block and has good demographic settlements with agriculture as the main occupation. The River Ganga forms the levee or upland all along its southern bank. In the south of the natural levee of the Ganga, there is a vast stretch of backwaters known as the *Tal* lands. These *tals* remain submerged into a 1 to 3 m of water column from mid June to mid October during monsoon period. Post monsoon from 15th October onwards, when the water level receeds in ganga rivers, these *tals* drain out their water in the ganga rivers. The area is characterized by fertile flat land which is highly prone to floods during the monsoon season. The alluvium deposits covering the entire region are of Quaternary period. The region is characterized by silt deposited from the river Ganges almost every year and is extremely fertile.

1.4.5 Physiography/DEM

The elevation in the area ranges from 26 m to 78 m above mean sea level. Broadly the area has flat topography *(Fig. 1.4)*

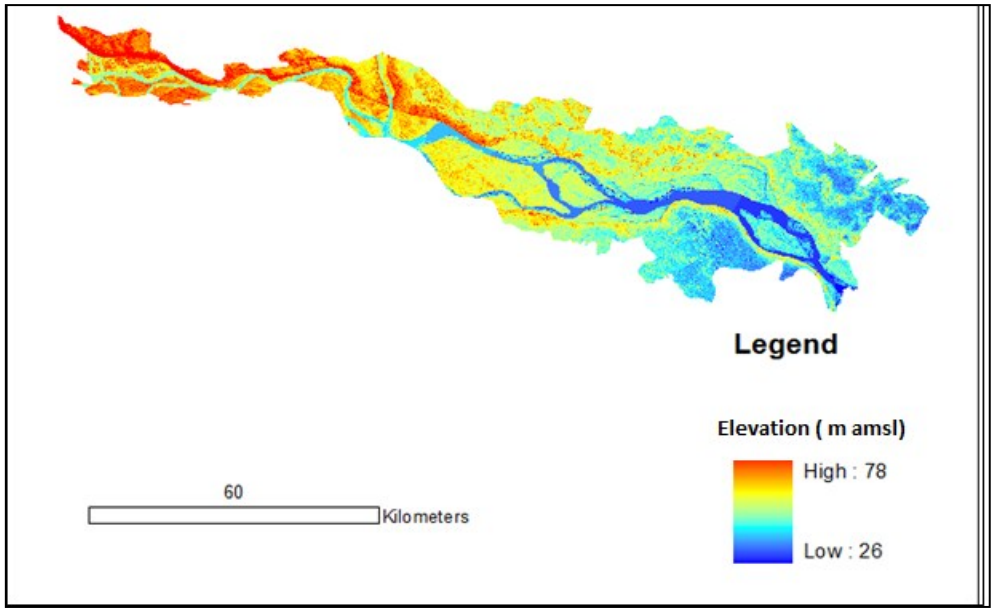


Fig. 1.4 Digital Elevation Model of the study area

1.4.6 Geomorphology

The study area forms part of the Middle Ganga Plain and physiographically it represents a monotonous flat topography. The land surface for the part located on the northern bank of the River Gnaga shows a general slope towards the south-east while for the part located on the southern flank of the Ganges, the general slope is towards north-east. The area is drained by rivers Ganga, Gandak and their tributaries (Fig. 1.4). The west - east flow of the River Ganga forms the axial drainage of the area. The River Ganga forms the levee or upland all along its southern bank. In the south of the natural levee of the Ganga, there is a vast stretch of backwaters known as the *Tal* lands.

The area is characterized by fertile flat land which is highly prone to floods during the monsoon season. The alluvium deposits covering the entire region are of Quaternary period.

The region is characterized by silt deposited from the river Ganges almost every year and is extremely fertile. The geomorphological map of the area (based on NRSA) is produced in Fig 1.5.

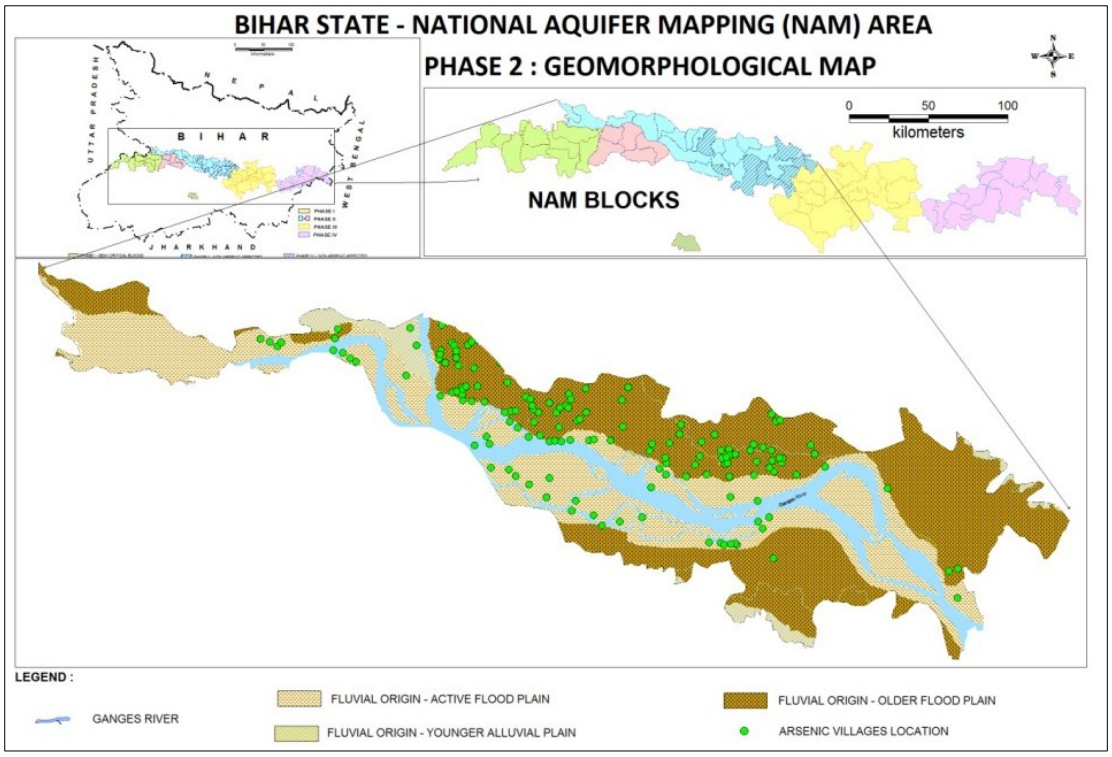


Fig. 1.5 Geomorphological Map

1.4.7 Landuse

Land use and land cover have direct linkage to the water demand of any area. The most reliable land use statistics are available from the reports of the Agriculture Department, Government of Bihar (2009), which provides district wise information.

Fig. 1.6 Landuse & Landcover Map

Of the total geographical area of 1,23, 3790 hectares of Saran, Vaishali, Samastipur, Beusarai and Patna districts, the net sown area is 79,7784 hectares respectively constituting nearly 65% of the total geographical area. The principal source of assured irrigation is by wells and tube wells, which together account for about 90% of the total irrigation. The cropping intensity of the five districts as a whole has been found to be 138%, however, Vaishali and Samastipur districts have higher cropping intensity as 156 and 164 % respectively (Table 1.5).

During the study, the landuse land cover map of the area falling under Phase 2 has been prepared based on the NRSA data. The landuse landcover map based on the NRSA data is produced as under in Fig. 1.6. *(Source: AgricultureDepartment, Govt. of Bihar)*

1.4.8 Soil

The area falling to the north of the River Ganga covering Saran, Vaishali, Samastipur and Begusarai districts, falls under the Agro-climatic zone I and is characterised by sandy loam and loamy soils with pH in the range of 6.5-8.4. The area located in the south of the River Ganga covering Patna district falls under the agroclimatic zone IIIB and is characterised

Table 1.5 District wise Land Utilisation Statement of Bihar during 2009-10 (unit : in hectares)

Sl. No.	Name of District	Geographical Area	Forest Area	Land put to Non-agriculturable use				Barren Uncultur-able Area	Permanent Pastures & Grazing Land	Land under Misc. Tree crop& Groves not included in net area sown	Culturable Waste Land	Fallow Land			Total Non-Agricultural Land	Net Sown Area (3-16)	Total Cropped Area	Area Sown more than once
				Land Area	Water		Total column: 5, 6 & 7					Other Fallow Land	Current Fallow land	Total				
					Parenial	Temporary												
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	**Patna**	317236	56	63732	10332	2429	76493	12369	113	989	764	1572	29120	30692	121476	**195760**	**227135**	31375
2	**Saran**	264887	0	27332	3464	2892	33688	17915	221	8553	161	3689	17674	21363	81901	**182986**	**230802**	47816
3	**Vaishali**	201449	0	28971	5827	2032	36830	24098	335	9709	141	308	5293	5601	76714	**124735**	**195639**	70904
4	**Samastipur**	262390	0	53903	8189	951	63043	3811	67	8211	0	977	4519	5496	80628	**181762**	**299734**	117972
5	**Begusarai**	187828	0	29732	7668	3967	41367	17961	16	3637	40	857	11409	12266	75287	**112541**	**150391**	37850
	Total	**1233790**	**56**	**203670**	**35480**	**12271**	**251421**	**76154**	**752**	**31099**	**1106**	**7403**	**68015**	**75418**	**436006**	**797784**	**1103701**	**305917**

by sandy loam, clay loam, loam and clayey soil with pH in the range of 6.8-8. The soils in general except those of the diara lands and Tal lands are moderately well drained to somewhat poorly drained.

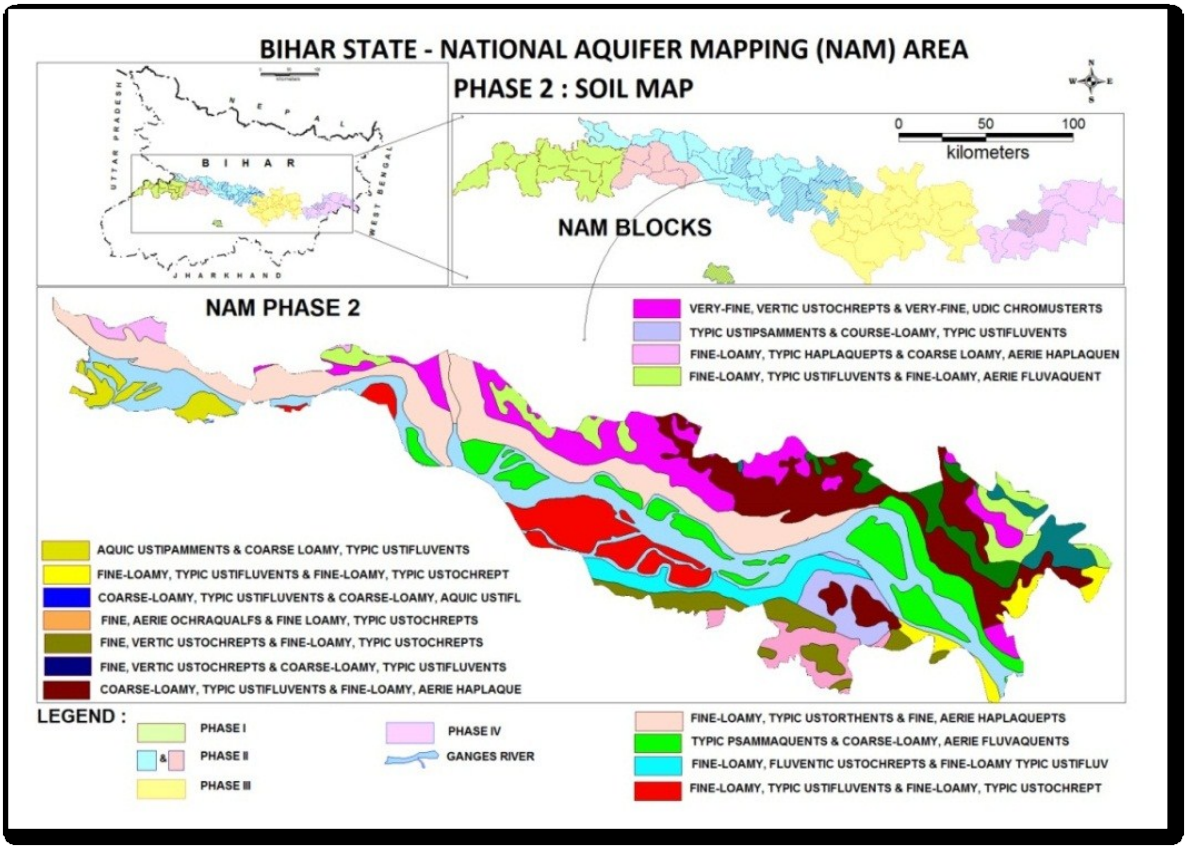


Fig. 1.7 Soil map of the study area

1.4.9 Hydrology and Drainage

The west to east flowing Ganga River forms the master drainage of the area. River Gandak from north joins the River Ganga in the western part of the study area at Sonepur near Patna. The part of the study area falling in Vaishali and samastipur district falls in the doab between the Ganga and the Burhi–Gandak. The other rivers in the are are the Baya, Balan, Jamuari etc flowing in NW-SE direction. Marshes and swamps locally known as *Chaurs* are common in the area.

Fig. 1.8 Drainage map of the study area

1.4.10 Agriculture

Agriculture is the mainstay of the population in the area. The northern part (located on the northern bank of the River Ganga) of the area falling in Saran, Vaishali, Samastipur and Begusarari districts fall in the Agroclimatic zone I while the southern part (located south of the River Ganga) falls in the agroclimatic zone III. The cropping pattern of the Zone I and III is discussed under the head cropping patterns.

1.4.11 Irrigation

The main source of irrigation in the area is through tube wells which accounts for irrigation in more than 97% of the total irrigated area in Saran, Samastipur and Begusarai districts. In Vaishali district, tube wells constitute the source of irrigation in about 85% of the irrigated area while in Patna district it accounts for irrigation in 67% of the irrigated area.

1.4.12 Cropping patterns

The area falling in Saran, Vaishali, Samastipur and Begusarai located to the north of the River Ganga falls under the agroclimatic zone I where the following cropping sequence is practised.

Zone – I : Rice – Wheat, Rice – Rai, Rice – Sweet Potato, Rice – Maize (Rabi), Maize – Wheat, Maize – Sweet Potato, Maize – Rai, Rice – Lentil, Rice-linseed

In Patna district, located to the south of the River Ganga falling in agroclimatic zone III, the cropping sequence practised is

Zone – III : Rice – Wheat, Rice – Gram, Rice – Lentil, Rice – Rai

1.4.13 Prevailing water conservation / recharge practices

A large part of the area remains seasonally water logged. In the northern part of the Ganga, these are locally known as *Chaurs* and remain seasonally water logged from July till February. In the south of the natural levee of the Ganga, there is a vast stretch of backwaters known as the *Tal* lands. These *tals* remain submerged into a 1 to 3 m of water column from mid June to mid October during monsoon period. These water bodies act as indirect sources of ground water recharge in the area.

1.5 Climate

Climate records available from the IMD database indicate that the area enjoys a typical subtropical climate. The summer season in the area begins from the middle of March when hot westerly winds, locally called as *Loo*, begin to blow during the day. The months of April and May are hottest with peak summer temperatures shooting upto 44 - 45° C. The summer season continues up to mid June. The winter season begins from November month and lasts till the beginning of March. January is the coldest month when the temperature comes down to as low as 4 - 5° C. The monsoon season intiates by the third week of June and continues till the end of September. There is slight rainfall in October but November and December are quite dry. The rainy season receives Southwest monsoon and accounts for about 90% of the total rainfall. The area receives an average normal monsoon rainfall of about 1100 mm/year.

1.6 Geology

The area forms a part of the Gangetic plain underlain by immensely thick alluvial deposits comprising sediments (sand, gravel and clay) of Quaternary age deposited unconformably over the Precambrian basement. The alluvial deposits are characteristically divided into the Older and the Younger Alluvium.

Older Alluvium

The Older Alluvium (called Bhangar in the Ganges valley) forms slightly elevated terraces, generally above the flood level. These are dark coloured and in general are rich in concretion and nodules of impure calcium carbonate known as *'kankar',* of various shapes and sizes.

Newer Alluvium

The Newer Alluvium is in general, light coloured and poor in calcareous matter. It contains lenticular beds of sand and gravel and peat beds. The geological map of the area is shown in the Fig. 1.9.

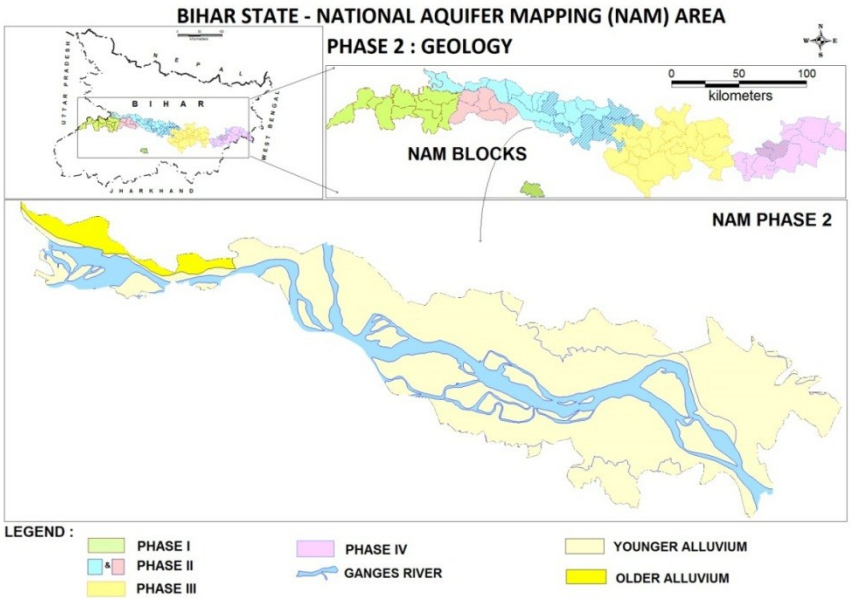


Fig 1.9: Geological Map of the area (Source: GSI)

The area is located in the central axial part of Middle Ganga Plain occupying the central part of the Ganga Basin. The Ganga basin is an active foreland basin formed in response to the uplift of Himalaya due to collision of the Indian and the Asian plate. The Middle Ganga Plain lies between the Munger-Saharsa ridge in the east and Faizabad ridge in the west exhibiting an asymmetrical sediment wedge, with thickness varying from less than a meter in basin margin areas with Peninsular craton to more than 5 km near the Himalayan orogen. The area forms a part of the Gangetic plains underlain by immensely thick alluvial deposits. Delineation of aquifer geometry based on the available data reveals presence of a thick pile of alluvial sediments of Quaternary age comprising various grades of clay, silt and sand which constitutes the ground water reservoir.

The sands brought and deposited by the Ganga are grey, micaceous and rich in ferromagnesian minerals and occupy the topmost horizon along the course of the river upto a few kilometres south of it constituting the newer alluvium consisting of clay, kankars, fine to coarse grained sands, gravels and pebbles at depths.

1.7 Sub surface lithological information

The area forms a part of the Gangetic plains underlain by immensely thick alluvial deposits. Assessment of the subsurface configuration of aquifer, based on the available data, reveals presence of a thick pile of alluvial sediments of Quaternary age comprising various grades of clay, silt and sand. A pervasive layer of clay mixed sand constitutes the top of the succession.

CHAPTER-II
DATA COLLECTION AND GENERATION

2.1 Hydrogeology

The area forms a part of the Gangetic plains underlain by immensely thick alluvial deposits. Assessment of the subsurface configuration of aquifer, based on the available data, reveals presence of a thick pile of alluvial sediments of Quaternary age comprising various grades of clay, silt and sand. A pervasive layer of clay mixed sand constitutes the top of the succession. The presence of kankar and fine sand makes this clay layer semi pervious. The area is characterized by occurrence of fairly thick sands of various grades forming prolific aquifers.

Available data indicate presence of two aquifer system up to 300mbgl. The deeper aquifer is made up of medium to coarse grained sand often grading to gravelly sand at the bottom.

2.1.1 *Water level, pumping tests, soil infiltration studies, slug tests*

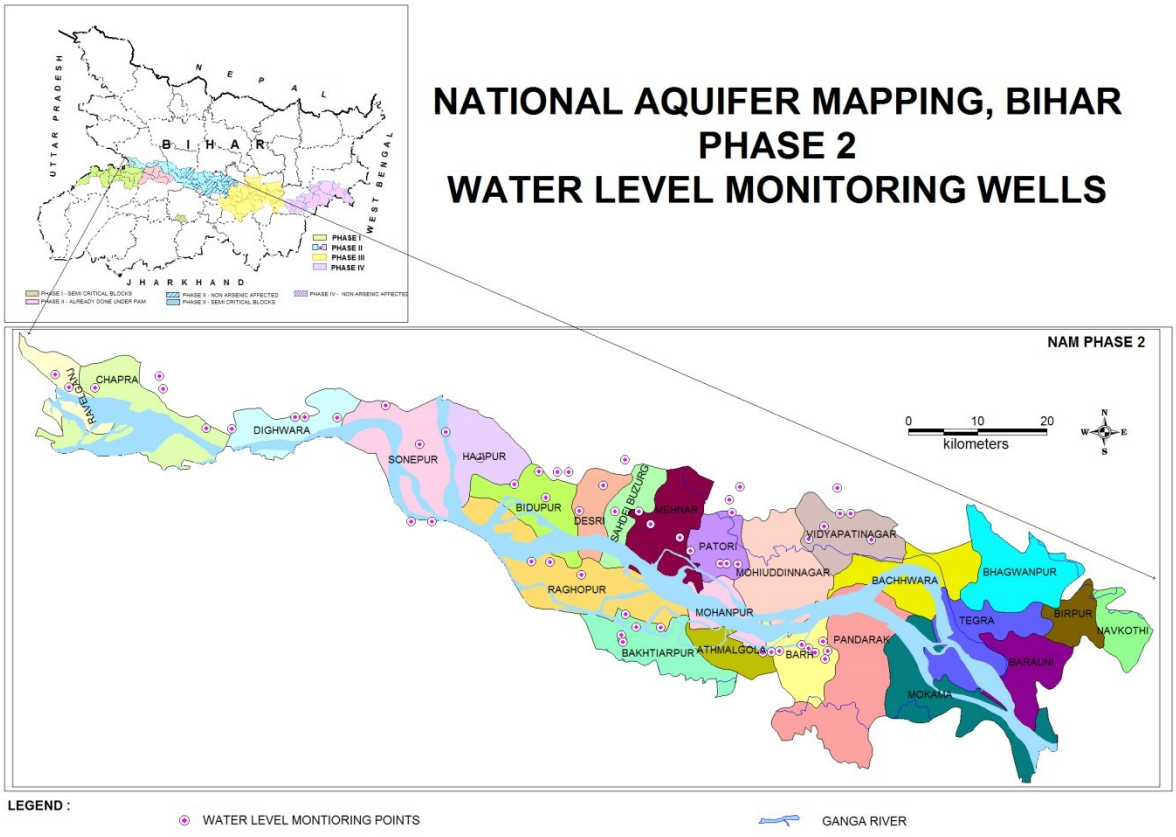


Fig. 2.1 Water level monitoring wells in the study area

Water Level

Ground Water monitoring has been carried out at 59 locations in the area during the year 2014-15 (Annexure I). The depth to water level representing the phreatic aquifer has been prepared for pre- and post-monsoon season. The depth to water level map of the study area for the pre-and post-monsoon period is produced as below (Fig. 2.2a & 2.2b).

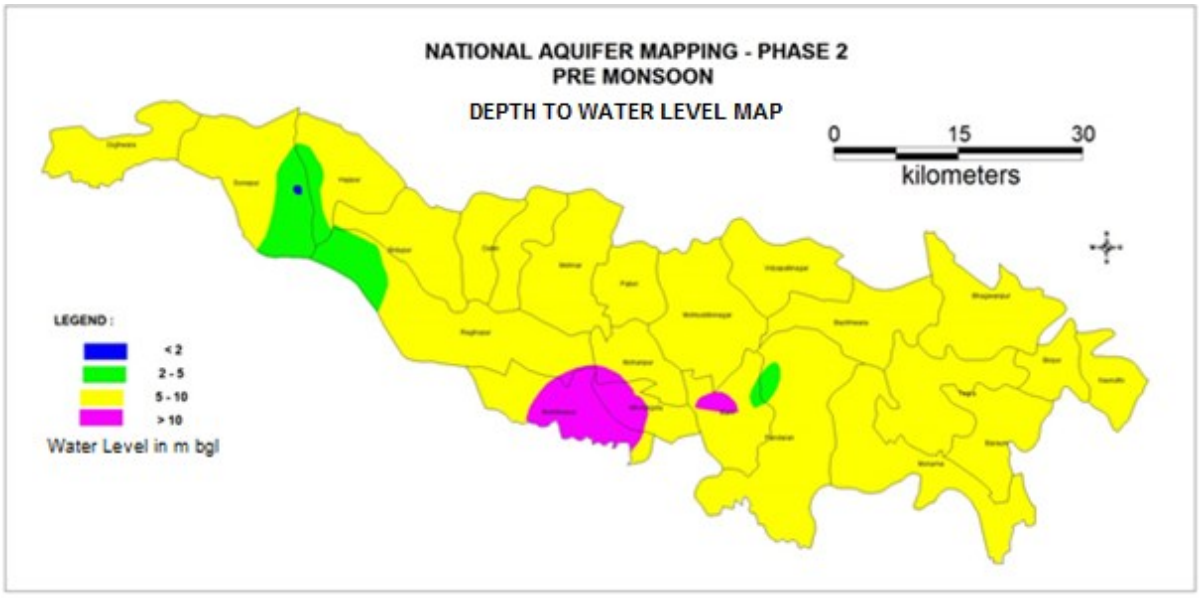


Fig. 2.2a Depth to water level map of pre-monsoon 2014

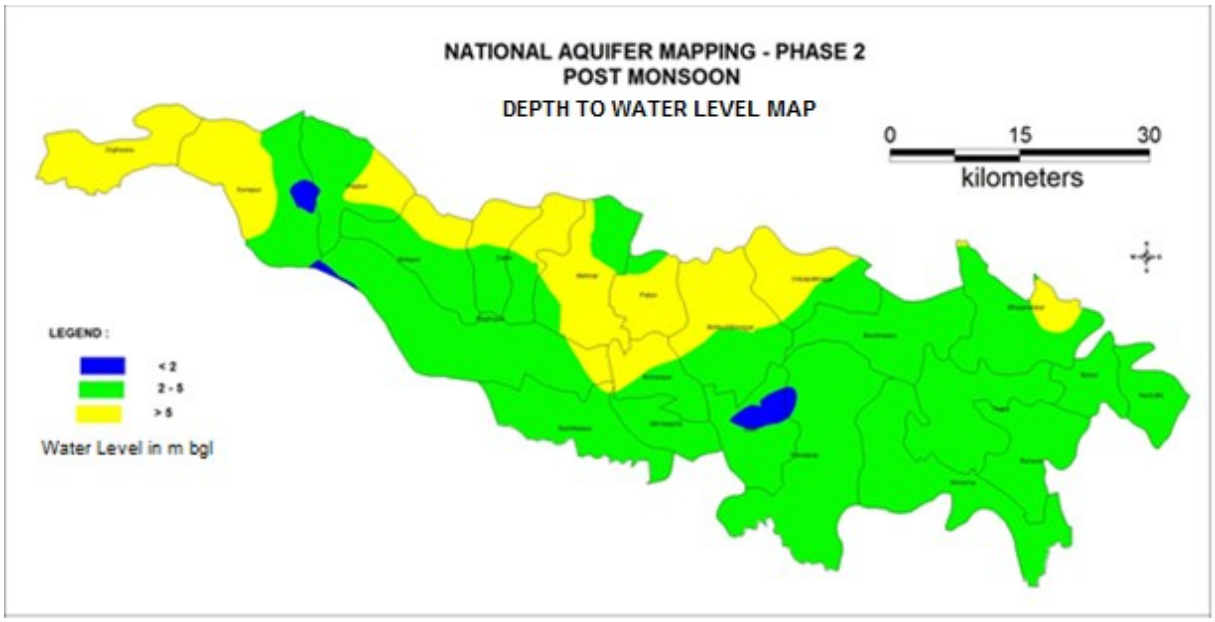


Fig. 2.2b Depth to water level map of post-monsoon 2015

The DTWL map of the area shows that majority of the area has water level of 5 – 10 m bgl in pre monsoon and 2 – 5 m bgl in post monsoon. In some parts, the water level is confined to 2 – 5 m bgl both in pre and post monsoon. In a part of Sonepur block, the water

level is found to be confined to < 2 m bgl in both pre and post monsoons. The water level in major parts of Bakhtiarpur and Barauni and few area in Barh block recedes to more than 10 m bgl in pre monsson season whereas in post monsoon it is confined to 2 – 5 m bgl.

Pumping tests

Pumping test data of CGWB wells (Table-2.1) indicate that the transmissivity value of the aquifers ranges between 1248 and 13,105 m^2day^{-1}. The storage coefficient has been found ranging between $1X10^{-2}$ and 3.5 $x10^{-6}$ respectively indicating that the deeper aquifer remains in semi-confined to confined condition.

Table 2.1 Salient features of CGWB exploratory wells

S.No.	Location	Depth drilled (m bgl)	Depth range of tapped Granular zones (m)	Discharge (m^3/hr.)	Drawdown (m)	Transmissivity (m^2/day)	Storativity
1	Barh	237	122-128, 134-140, 170-176, 179-182, 205-211, 220-226	191.3	4.4	9333	$1.8*10^{-2}$
2	Madudabad	302	90-96,116-128,132-138,222-228	208	3.71	9002	$1*10^{-2}$
3	Vidyapati nagar	256	210-222	56.8	5.78	**1248**	$3.5*10^{-6}$
4	Kancha	200	98-100, 116-128	73.8	4.28	2703	$1.025*10^{-2}$
5	Shahpur Patori	129	80-86, 90-102	194.5	3.85	5340	$6.3*10^{-4}$
6	Barauni	252.5	154-160, 194-200, 221-223	179.5	9.11	7888	$9.2*10^{-5}$
7	Gyaspur	252.7	92-100, 116-122, 140-146, 150-156, 168-174, 180-188	194.6	2.69	**9425**	
8	Bihat	233.75	140-146, 160-166, 175-187	84	5.4	2380	
9	Teghra	182	125-127,146-154,170-178	211	5.61		
10	Sewri, Cheria Bariarpur	396	208-225,230-241,261-280	127..2	6.52	13105	$8.39*10^{-3}$
11	Bikrampur, Cheria Bariarpur	452	208-219,224-240	136.2	9.7	5460	$1.75*10^{-4}$

Soil infiltration studies

To know the infiltration rate of water, it is important to find out the type of soil present in the area. For this, infiltration tests where done in the NAQUIM area at three blocks

namely Dighwara (Saran district), Sonepur (Vaishali district) and Hajipur (Vaishali district). It was found out that the soil type in most of the area is fine loamy to coarse loamy in nature. The soil is alluvial type influenced by flooding from Ganga and its tributary river.

2.2 Hydrochemical

2.2.1 Water quality sampling, number of samples and analysis mechanism

Groundwater is the most important and essential natural resource for domestic, industrial and agricultural needs. Water quality in an area is a function of physical and chemical parameters that are greatly influenced by geological formations and anthropogenic activities.

Quality of ground water is as much demanding as its quantity. Suitability of ground water for drinking and irrigational purpose is important for its safe and effective use. The state of Bihar is mainly dependent on ground water for the domestic and irrigation demand .The pressure on ground water is considerable also in the Pilot aquifer mapping area to meet urban and rural water requirements as well as the irrigation requirements in the semi-urban and rural areas. Chemically, the ground water is an aqueous solution in the sub-surface geological formation. The concentration of the major ions and other dissolved ions in ground water are functions of the availability of the constituents in the aquifer matrices and their solubility. Rocks, through which water circulate, are composed of minerals and amorphous solids, which in turn are composed of chemical elements that greatly affect the ground water quality.

To study the groundwater chemistry of different aquifer present in the area, a total no. of 103 groundwater samples was collected from different aquifers during different time periods for analysis of major parameters (Annexure II). The water samples were collected and stored in 1 liter capacity clean plastic bottles. Before collection of samples, the bottles were properly washed. Prior to collecting the samples, the containers were rinsed by the water to be sampled. The wells were duly pumped before collecting ground water sample so that the stagnant water, if any, is completely removed from storage within the well assembly

These water samples were analysed in chemical laboratory of CGWB MER-Patna, and PHED, Govt. of Bihar. Besides these, available historical data of chemical analysis of ground water were also studied to have an understanding of ground water chemistry of the area. Analytical results of ground water samples are given in the annexure II.

Classification of groundwater

In order to understand the chemical characteristics of groundwater in the study area, groundwater samples were plotted in Piper trilinear diagram (Piper 1944) using AquaChem software (Fig.2.3). Figure. show that groundwater smples are classified as various chemical types on the Piper diagram. The dominant water types are in the order of $CaHCO_3$ > Mixed CaMgCl > Mixed $CaNaHCO_3$ > NaCl. However, most of the samples are Ca-HCO_3 type. The Ca–HCO_3 water is primarily a result of dissolution of carbonate minerals, and the origin of water is mainly due to rainfall-derived recharge, over decades to centuries, whereby surface water charged with atmospheric and biogenic CO_2 infiltrates into the subsurface. Mixed CaMgCl and $CaNaHCO_3$ water type express mineral dissolution and recharge of freshwater. NaCl water type suggest the mixing of high salinity water caused from surface contamination sources such as irrigation return flow, domestic westewater, and septic tank effluents, with existing water followed by ion exchange reactions. Sixty two percent of the sample indicate $CaHCO_3$ type, 17% are Mixed CaMgCl type, 16% sample show Mixed $CaNaHCO_3$ type and 5% are Na Cl type water. On the basis of Piper diagram, groundwater of the study area is suitable for drinking purposes.

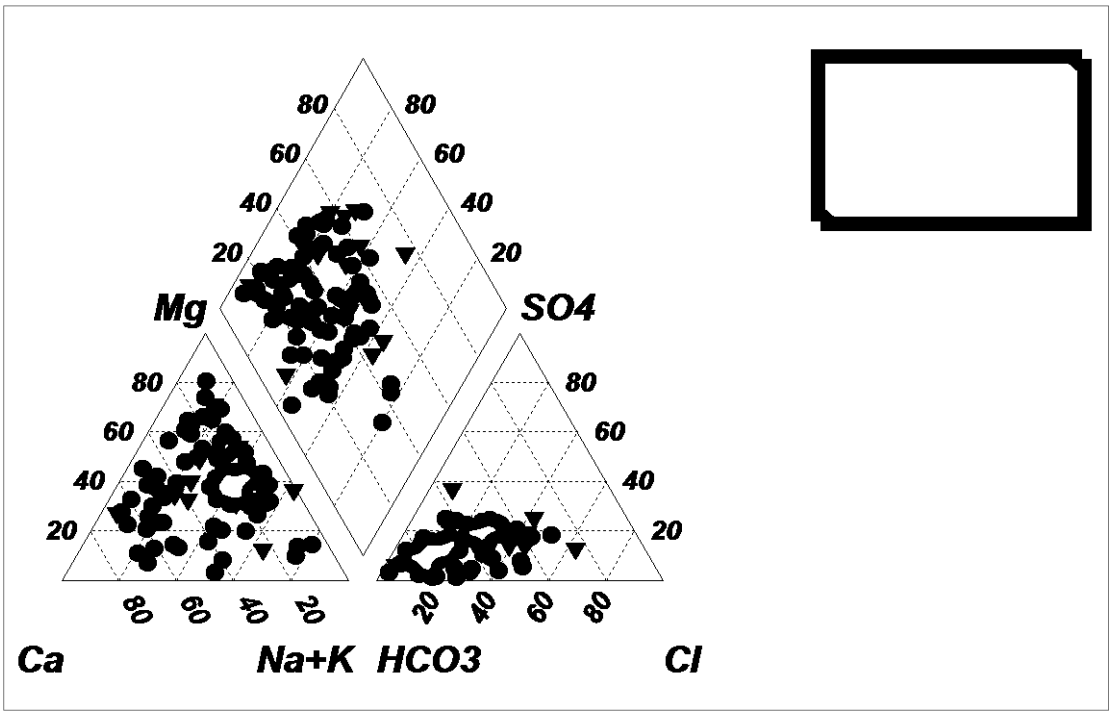


Fig. 2.3 Piper's Diagram of the ground water samples

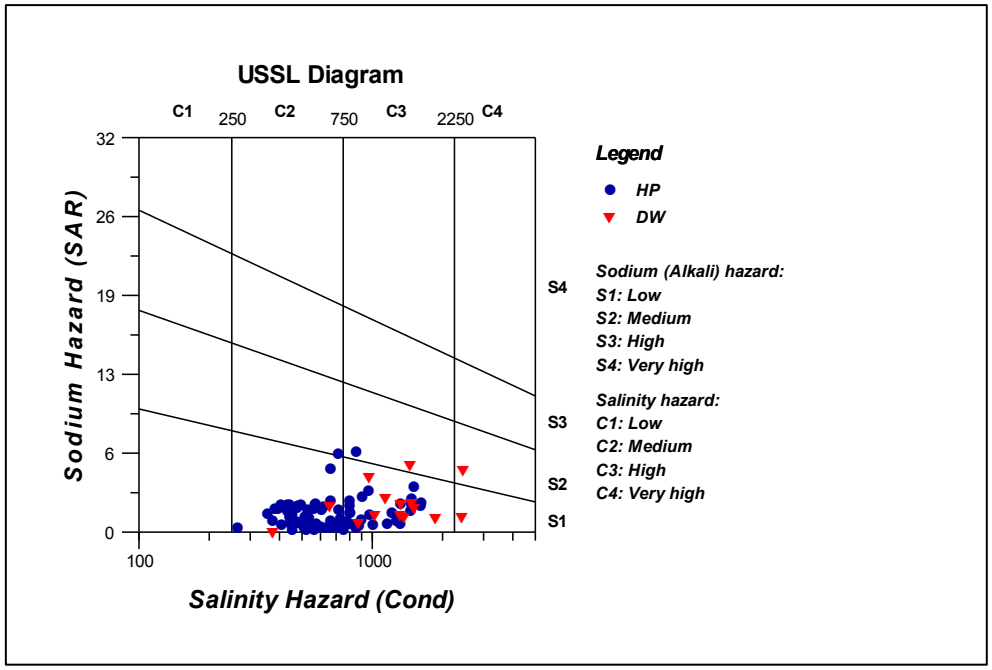


Fig. 2.4 USSL diagram

On the basis of USSL diagram, (Fig 2.4) groundwater of the study area are suitable for irrigation purposes.

Ground water quality problem in the Watershed

The major issue in ground water quality problem of the study area was high arsenic level (> 50 ppb which is the limit considered for drinking water) as reported by PHED,Govt. of Bihar and analysis of Ground water sample by CGWB from area. Arsenic concentration of the study area are given in Annexure- IIIa & b.

Aquifer disposition

The subsurface configuration of aquifer has been made based on available lithological logs of CGWB and State agencies along with interpreted records from VES survey. Several sections along different orientation have been prepared to depict aquifer geometry. The lithologs and the geophysical logs reveal the presence of a thick pile of alluvial sediments with alternating sequence of various grades of sand with clay and silt.

2.3 Geophysical

2.3.1 Location, number, analytical techniques

66 Surface electrical resistivity investigation (VES) was carried out by CGWB within the study area. The field data were interpreted with the help of empirical curves (Master curves) based on curve matching technique and computer based software. On the basis of

interpreted results, geoelectrical sections have been prepared and vertical and horizontal disposition of granular zones of various grades are analysed within the investigated area.

Surface geophysical survey:

In all 66 VES were performed within the aquifer mapping area. The VES were performed in the field and the data were interpreted with computer and manual process. The interpreted VES data of the area is given in annexure IV.

Instrument used

During the surface resistivity investigation a Syscal R2 resistivity meter (manufactured by IRIS, France) was used. The instrument measures potential differences between two potential electrodes when current is sent through two current electrodes and there by apparent resistivity is calculated automatically by the instrument.

All the curves are interpreted with the help of partial curve matching technique and also by the resistivity sounding interpretation software. The interpreted data is correlated with the available borehole information near by the survey area and the following resistivity range with respect to lithology is given as follows:-

Resistivity range (Ω-m)	Lithology
9 -15	Clay
14-30	Sand mixed with little clay
16 -25	Fine Sand
30 -50	Medium to Coarse Sand
60-200	Coarse sand mixed with gravel/Kankar
200-500	Desaturated sand

Ω-m = ohm metre

All the interpreted results are tabulated in the Annexure-IV.

2.4 Exploratory drilling-State, CGWB and private wells

2.4.1 *Number, location, depths, well design*

Sub-surface lithological information (> 200m, bgl) from the available drilling records of exploratory well of CGWB have been tabulated in Table 2.2 (Fig 2.5). The lithologs of the wells are given in annexure v.

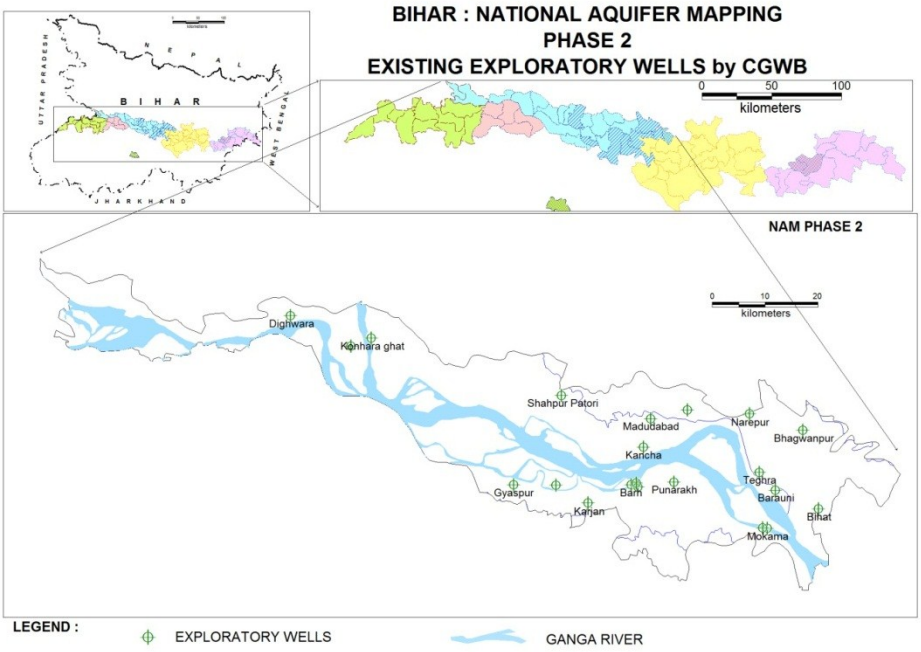


Fig 2.5: Locations of exploratory wells (drilled by CGWB)

Table 2.2a: Location detail of wells drilled by CGWB

S No	Location	Long	Lat	Depth drilled (m bgl)
1	**Barh**	85.6919	25.4735	237
2	**Madudabad**	85.7285	25.5862	302
3	**Vidyapati nagar**	85.7984	25.6011	256
4	**Kancha**	85.715	25.538	200
5	**Shahpur Patori**	85.5599	25.6261	129
6	**Barauni**	85.965	25.4643	252.5
7	**Gyaspur**	85.4689	25.4737	252.7
8	**Bihat**	86.0465	25.4325	233.75
9	**Teghra**	85.9344	25.4946	182

In addition to the CGWB data, liothlogs of 18 borewells from other sources have also been collected, the locations details of which are given in table. The lithologs of these wells are given in annexure. These lithologs are available mainly up to 100m and hence providing lithological information up to 100m bgl only.

Table 2.2b: Location detail of bore well drilled by other agencies

S. No.	Location	Longitude	Latitude	Depth drilled (m bgl)
1	**Sirdilpur**	85.5694	25.6300	103.94
2	**Suahpur Undi**	85.5907	25.6357	110.64
3	**Hatharua**	85.6113	25.6232	110
4	**Sehura**	85.6187	25.5957	131.37
5	**Mohammadpur**	85.6689	25.5640	91.75
6	**Sultanpur**	85.6988	25.5369	79.25
7	**Barhouna**	85.7418	25.5853	92.96
8	**Harpur Bochaha**	85.7546	25.5959	90.53
9	**Morwa Gopalpur**	85.7694	25.5758	81.68
10	**Mau**	85.7771	25.5768	91.74
11	**Sherpur**	85.7850	25.5899	91.74
12	**Chiranjivpur**	85.8743	25.6175	139.59
13	**Bachhwara**	85.8980	25.5807	97.54
14	**Rani**	85.9093	25.5620	85.34
15		85.9320	25.5228	121.92
16	**Rasulpur**	85.9555	25.5328	71
17	**Mukhtiarpur**	85.9813	25.5704	113.08
18	**Hawaspur**	85.9294	25.6186	145.08

CHAPTER-III
GENERATION OF AQUIFER MAP

3.1 Aquifer Disposition

The study area is located in the central axial part of Middle Ganga Plain occupying the central part of the Ganga Basin. The area forms a part of the Gangetic plains underlain by immensely thick alluvial deposits of Quaternary age comprising various grades of clay, silt and sand which constitutes the ground water reservoir.

3.1.1 Aquifer disposition in the area

To know the aquifer disposition in the study area, separate sections and fence diagrams have also been prepared based on the lithological information obtained through exploratory drilling undertaken by CGWB in conjunction with the available lithological logs of tubewells constructed by State Government.

From the geological sections and fence diagrams prepared the detailed aquifer geometry on regional scale has been established in the study area. Principal aquifers in the area have been delineated by grouping the fine to medium sand, coarse sand and gravelly sand as aquifers.

Aquifer disposition of the area are described through various sections and fence diagram prepared in different orientation and have been presented as under.

The sections reveal that the area is underlain by a two-tier aquifer system. A notable difference lies in the section on the northen and the southern bank of the River Ganga. In the northern bank, the clay layer separating the 1st and the 2nd aquifer is reasonably thick (20-35m) and occurs in the depth range of 130-145m, whereas, south of the River Ganga, the clay layer separating the 1st and the 2nd aquifer is comparatively much thinner (8-12m) and occurs at the depth range of 85-100m. Hydrogeological section is depicted in fig 3.1, 3.2 & 3.4.

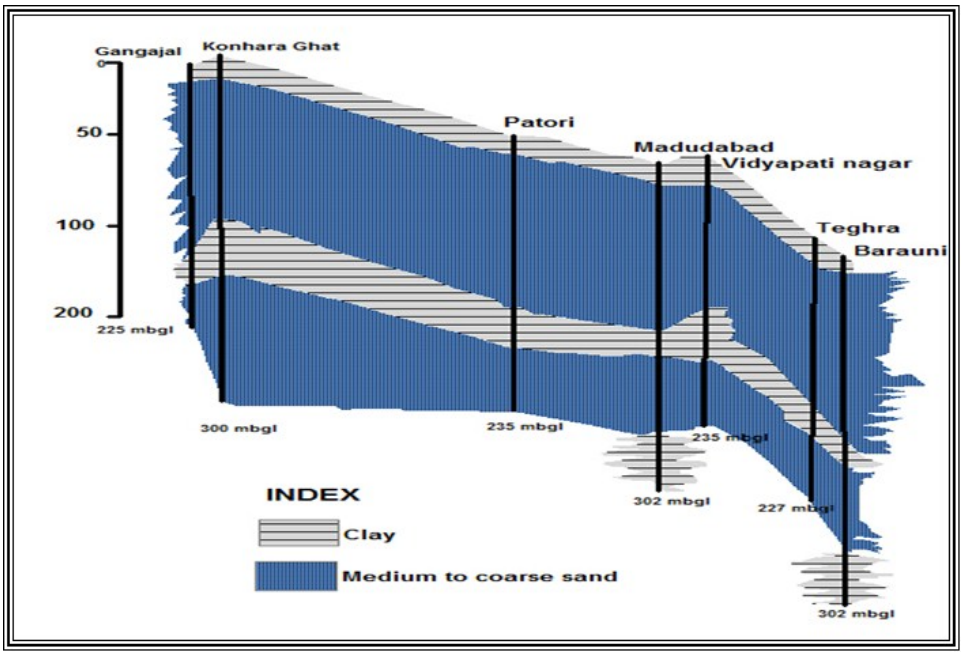


Fig. 3.1 Hydrogeological section fom Gangajal to Barauni.

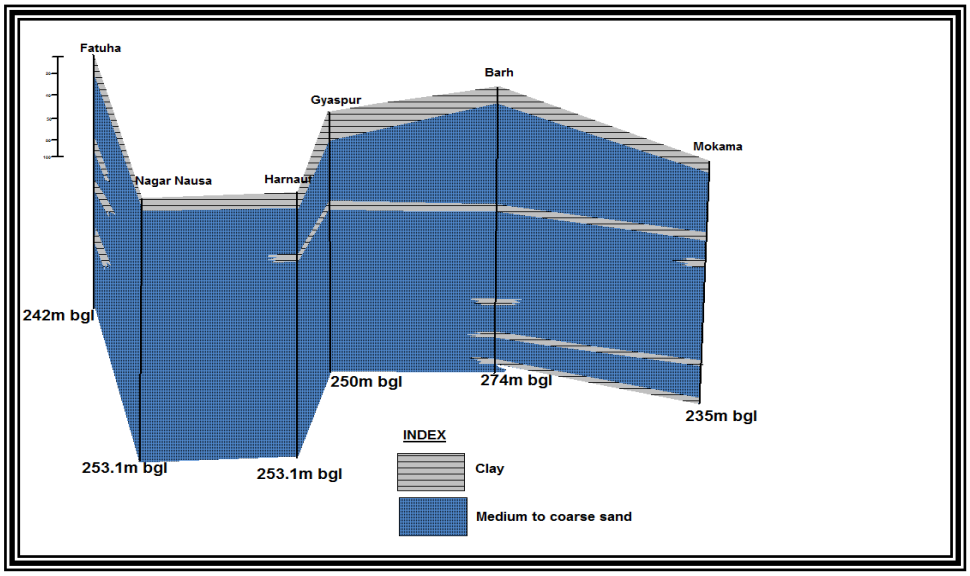


Fig. 3.2 Hydrogeological section from Fathua to Mokama.

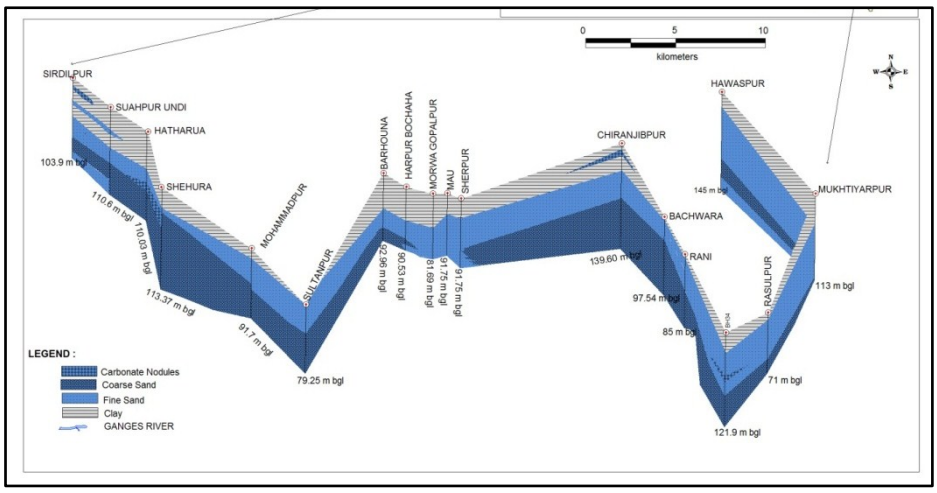


Fig. 3.3 Hydrogeological section from Sirdilpur to Hawaspur.

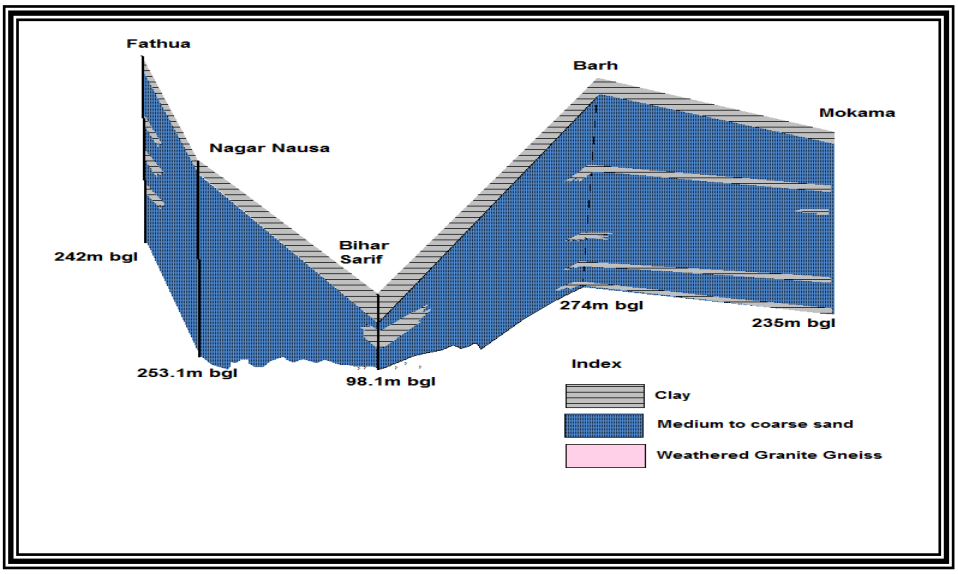


Fig. 3.4 Hydrogeological section from Fathua to Mokama.

3.1.2 Aquifer Characterizations

Characterization of aquifer upto 300 m bgl in the study area have been arrived at by convergence of the observations from the study of the different lithological sections, fence diagrams, geoelectrical sections, sections based on elogs and overall lithological model of the area. All these figures reveal the presence of a thick pile of alluvial sediments with alternation of various grades of sand with clay and silt. The area is characterized by occurrence of fairly thick sands of various grades forming prolific aquifers.

The study of sections, fence diagram and lithological model indicate that there are mainly two principal aquifer system in the area up to depth of 300m depth.

A 3D view of the aquifer disposition has been prepared which provide a clear impression of the spatial variation of aquifer thickness in the area.

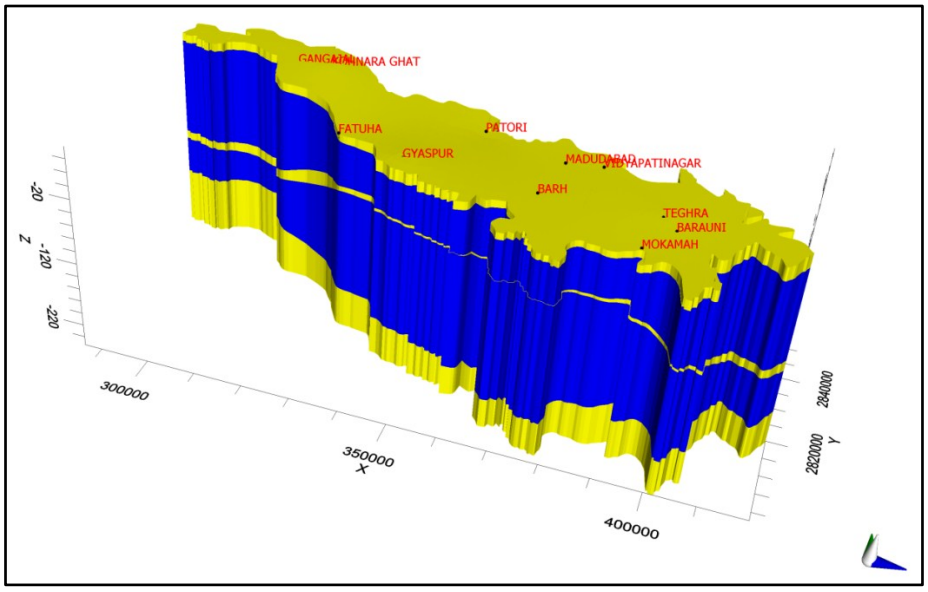


Fig.3.5a 3D view of aquiferdisposition

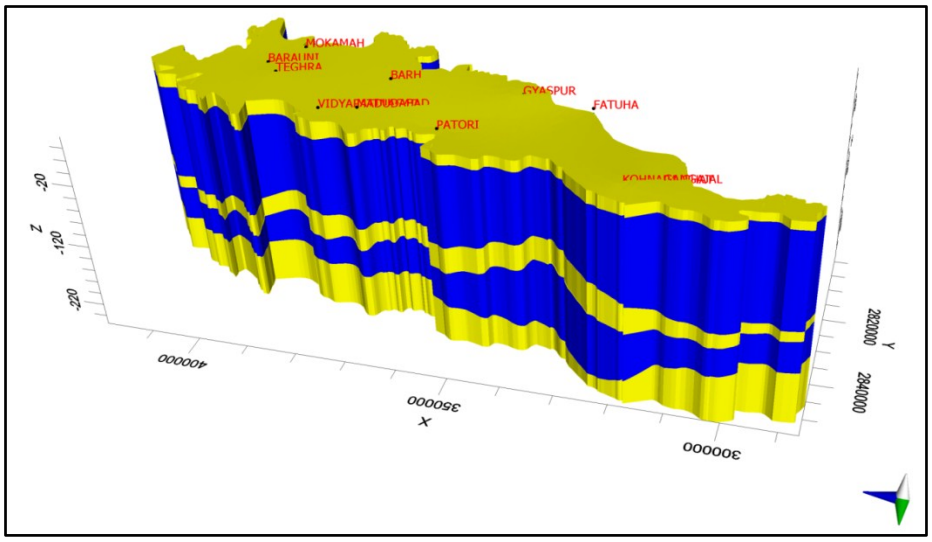


Fig. 3.5b 3D view of aquifer disposition

Perusals of these sections indicatethat there are two principal aquifers below the top aquitard layer (water table aquifer) upto 300m depth separated by clay and sandy clay layers

3.1.3 Aquifer disposition and its hydraulic characteristics

The aquifer geometry and its characterisation up to 300 m bgl have been studied through drilling at various parts of arsenic affected areas of Bihar

CGWB has drilled number of wells in the area tapping multiple zones in different aquifers. Pumping test data of CGWB wells have been analysed to arrive at the hyydraulic characteristics of the aquifers. These apart, the data of the wells constructed by State Government indicate that the shallow tubewells tapping first aquifer (within 110m bgl) can yield upto 215 m^3/hr for a drawdown rangining from 1.8- 5 m.

Salient characteristic of the exploratory wells drilled by CGWB in the area is given in table 2.1. Perusal of these data reveal significant potentiality of the aquifer of the area as the transmissivity ranges between 1248 and 9425 m^2day^{-1} with mean value of 6588 m^2day^{-1}. The storage coefficient has been found ranging from $1x10^{-2}$ to $9.2x10^{-5}$ respectively, indicating semi confined to confined conditions.

CHAPTER-IV

GROUND WATER RESOURCES

4.1 Dynamic ground water resources

The dynamic ground water resources of the 25 Blocks of Saran, Vaishali, Samastipur, Begusarai and Patna district as per the assessment made as on March 2011 is presented as under. The overall stage of groundwater development in the area is 50.9 % and all the Blocks except two blcoks (Naokothi and Birpur in Begusarai district) have been categorised under safe category on the basis of the status of ground water utilisation.

Perusal of the dynamic ground water resource (Annexure V) indicates that the existing stage of groundwater development varies from 33.5% in Mohanpur Block (Samastipur District) to 97.5 % in Naokothi block (Begusarai District). Considering the nature of the aquifers in the study area, recommendations for increasing groundwater development upto 70% stage of development can be made. The number of additional shallow tube wells that can be recommended in different blocks considering the above criteria is as under (Table 4.1).

Table 4.1 The number of additional shallow tube wells

S. No.	Block	District	No of additional shallow tube wells Recommended (allowing stage of development upto 70%)
1	Bachhawara	Begusarai	0
2	Bhagwanpur	Begusarai	0
3	Birpur	Begusarai	0
4	Naokothi	Begusarai	0
5	Teghra	Begusarai	138
6	Mohanpur	Samastipur	236
7	Mohiaddinagar	Samastipur	104
8	Patori	Samastipur	341
9	Vidyapatinagar	Samastipur	0
10	Biddupur	Vaishali	801
11	Hazipur	Vaishali	0
12	Mahnar	Vaishali	0
13	Raghopur	Vaishali	573
14	Sahdai Bizurg	Vaishali	40
15	Dighwara	Saran	0
16	Sonpur	Saran	200
17	Chapra	Saran	78
18	Revelganj	Saran	168

19	Athmalgola	Patna	0
20	Bakhtiapur	Patna	474
21	Barh	Patna	45
22	Mokama	Patna	275
23	Pandarak	Patna	501

4.4 Static resource and extraction from unconfined aquifer as well as in/from deeper aquifers

In the present exercise, attempt has been made to estimate the avaialability of the total ground water resource in the aquifers. In order to estimate the total availability of groundwater resource, a generalized 3 D disposition of the aquifer has been made using Visual Modflow Flex package. To prepare the 3 D disposition of the aquifers, a number of lithological logs available for the study area have been considered along with the results of the geophysical investigations made in the area. The generalized 3 D disposition of the aquifer represents the Principal aquifer groups. A number of minor layers/clay intercalations recorded in the individual lithological logs have been subsumed into the dominant lithological layers immediatedly overlying/underlying it.

The avaialablity of the total ground water resource in Aquifer I considering an average specific yield of 4% has been worked out as 13,400 MCM. Thus it can be surmised that the area is blessed with significant groundwater reserves which can be harnessed during the lean seasons. The distribution of the total groundwater resource has been apportioned Block wise considering the variation in the thickness of the Aquifer I in different Blocks. The Block wise estimated total resource in Aquifer I is as under (Table 4.2).

Table 4.2 Block wise estimated total resource in Aquifer I

Block	Total Area (in Sq. Km.)	Average thickness of Aquifer I in each Block (m)	Total available Ground Water resource Aquifer I (MCM)
Ravelganj	74	140	413
Chapra	201	140	1122
Dighwara	98	140	547
Sonepur	182	140	1016
Mokama	177	70	494
Hajipur	112	120	536
Raghopur	234	80	747
Bidupur	108	120	517

Desri	62	120	297
Sahdai Buzurg	64	120	306
Mahnar	139	130	721
Patori	68	130	353
Mohanpur	70	100	279
Mohiuddinagar	160	120	766
Vidyapati Nagar	108	120	517
Bhagwanpur	142	130	736
Bachhwara	125	120	598
Teghra	139	120	665
Barauni	102	120	488
Birpur	51	140	285
Naokothi	56	140	313
Bakhtiarpur	115	80	367
Athmalgola	54	85	183
Barh	97	80	318
Pandarak	241	85	817
	2979		13400

CHAPTER-V
GROUND WATER RELATED ISSUES

5.1 Identification of issues

The most important groundwater issue in the study area is the arsenic contamination of groundwater affecting the upper part of the 1st aquifer. Detialed investigations carried out by CGWB have established that the 2nd aquifer occurring below the 1st aquifer and separated from it by an aquitard layer is free from arsenic contamination.

5.2 Major Ground Water Issues:

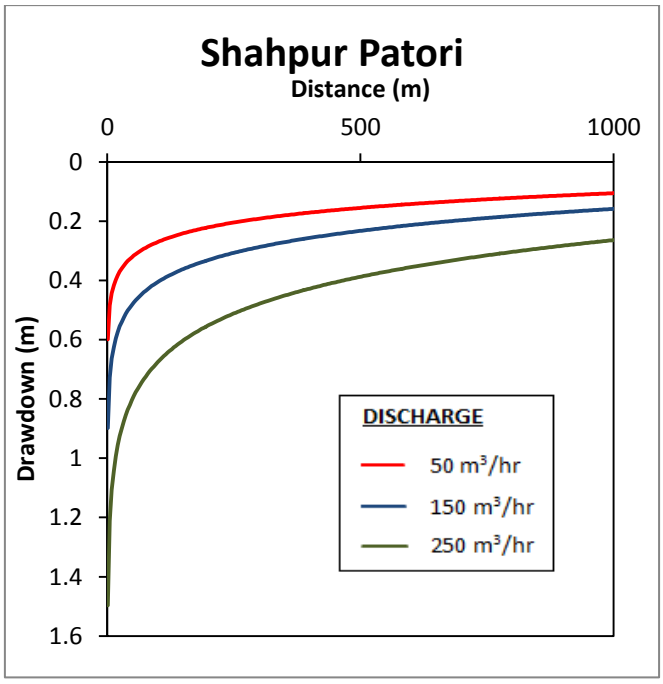
- Arsenic contamination affecting the 1st aquifer
- Contamination levels locally reaching upto 700 ppb
- Large population living in the affected villages (≈ 8 lakhs in 183 arsenic affected villages in 15 Blocks)
- Patchiness in distribution of contamination
- Delayed drainage in “tal” areas of Patna district which impacts the agricultural productivity in Rabi season

CHAPTER-VI
MANAGEMENT STRATEGIES

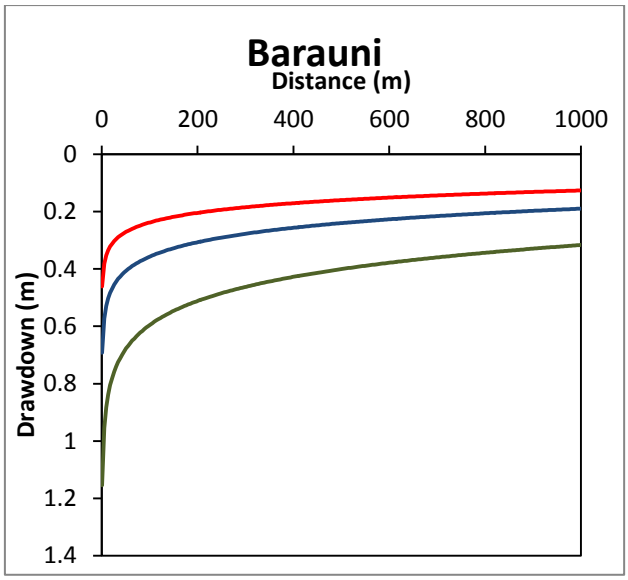
In order to address the problem of groundwater contamination in the affected area and to ensure safe water supply in the affected villages, it is important to prepare the groundwater development plan from the 2nd aquifer which has been found as arsenic safe considering the aquifer characterisitics so as to ward off any possible threats of cross-contamination of the 2nd aquifer from the 1st aquifer through vertical leakance. A distance- drawdown analysis has been carried out for preparing the development plan for the 2nd aquifer.

6.1 Distance- Drawdown Modeling of the 2nd aquifer

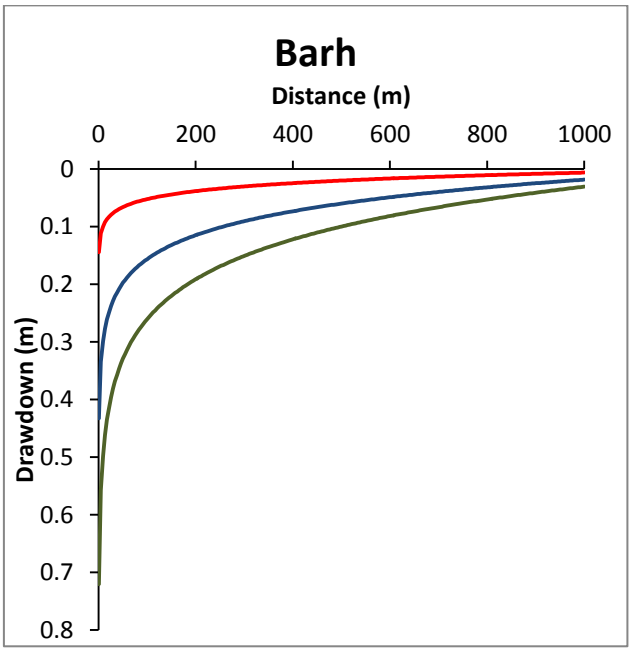
Central Ground Water Board has carried out exploratory drilling to delineate the arsenic safe deeper aquifers in the study area. The exploratory drilling has confirmed the presence of potential deeper aquifer system in the study area characterised by very low arsenic concentration and has been found safe for drinking uses. Using the field determined aquifer parameters, an attempt has been made to determine the spacing criteria for community water supply wells in the arsenic affected areas. The drawdown at the end of a day's pumping at various distances (r) for discharge of 250m^3/hr and 50 m^3/hr are shown in the table below. The shape of the cone of the depression formed ignoring the well loss component is shown in the following figures (fig. 6.1a,b,c & d)



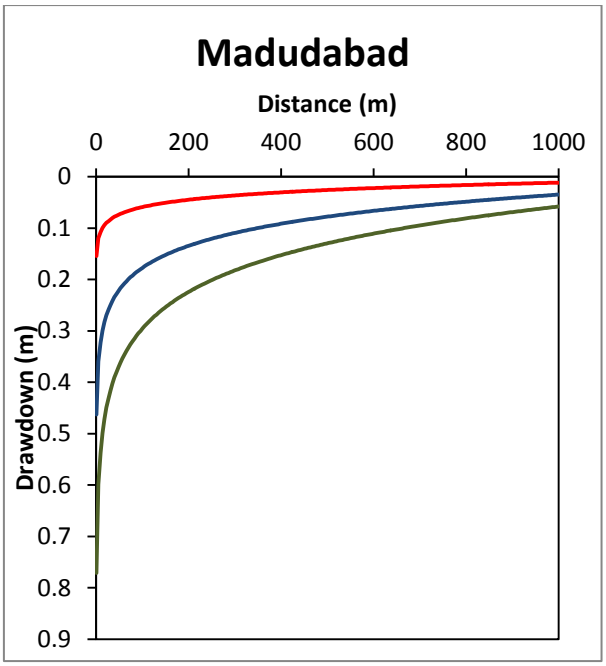
(a)


Barauni
Distance (m)
0
200
400
600
800
1000
Drawdown (m)
0
0.2
0.4
0.6
0.8
1
1.2
1.4

(b)


Barh
Distance (m)
0
200
400
600
800
1000
Drawdown (m)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8

(c)



(d)

Fig. 6.1a, b, c & d: Distance - Drawdown behaviour of 2nd Aquifer for varying discharge rate

Considering a drawdown of 5 cm as acceptable, it is recommended to design the water supply schemes tapping the deeper aquifers for a maximum discharge of 50 m^3/hr with a minimum of 3 Km as spacing between the two adjacent water supply schemes.

6.2 Proposed Design of Arsenic Free Wells

Development of the deeper aquifers should be made through properly designed wells which must be sealed from the overlying contaminated aquifers through cement sealing. The cement sealing is applied to a suitably thick intervening clay layer separating the arsenic contaminated aquifer from arsenic free aquifer. This cement seal prevents seeping of contaminated water through the annular space which
is filled with gravels. A schematic design is presented as under (fig 6.2).

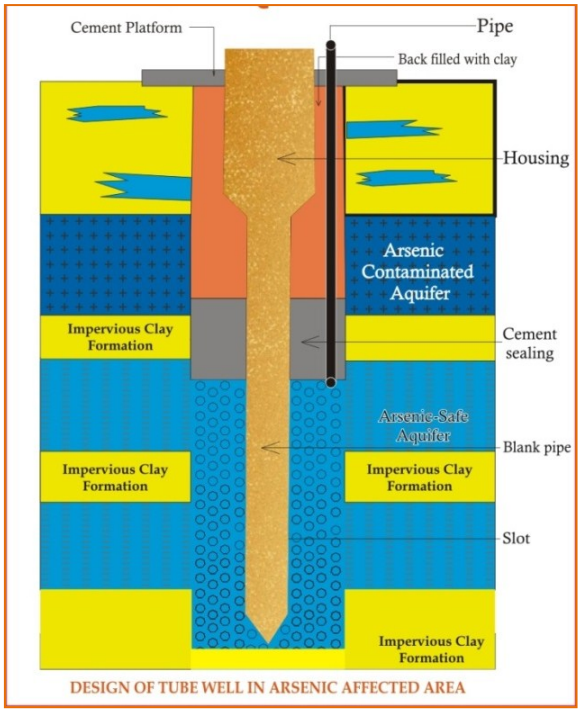


Fig 6.2: Schematic design of tube well with cement seal for arsenic affected area.

Suggested Plan

- The 2nd aquifer should be considered only for drinking water supply
- Maximum recommended discharge from 2nd Aquifer: 50m^3/h
- Minimum spacing between wells: 3 Km

6.3 Implementation plan and recommendation

The most important groundwater issue in the study area is the arsenic contamination of groundwater reported from the 15 out of the 25 blocks affecting the upper part of the 1st aquifer. Detialed investigations carried out by CGWB have established that the 2nd aquifer occurring below the 1st aquifer and separated from it by an aquitard layer is free from arsenic contamination. However, the most important management challenge in the area lies in protecting the deeper aquifers from the threats of cross-contamination. At the present level of our understanding of the arsenic contamination, prediction of the future arsenic concentrations is not possible. Studies have also cautioned over the development of the deeper aquifers. To arrive at a sustainable development strategy for the deeper aquifers in the arsenic affected areas, a distance-drawdown analysis for varying puping rates has been attempted for the deeper aquifers in the affected areas on the basis of the aquifer parameters of the

2nd aquifer. From the analysis it has been observed that in order to minimize the effects of well interference, water supply schemes in the affected Blocks should be designed for a maximum discharge of 50m^3/hr only and the radial distance between two pumping schemes should be kept at a minimum of 3 Km. On this basis, the number of schemes recommended for each Blocks is as under.

6.4 Requirement of deep tubewell schemes for piped water supply

Groundwater in the dug well zone has been found to contain low arsenic load and considering the 50 ppb as the limit, they have been found as safe in the study area (Table 6.1). However, owing to the prevalence of the handpumps and the ease of drawing water from it, dugwells are sparingly being used. The other concern with the dug wells is the faecal contamination resulting in high bacteriological load. However, if the existing dug wells are revived and care is taken to protect them from sewage contamination, the dugwells can be an alternative source of water supply. The UNICEF model of converting the dugwells into sanitary wells is also recommended.

A detailed study involving experts from agriculture, soil science, agronomy, chemistry and hydrogeology is required to assess the impact of the use of the arsenic contaminated groundwater for irrigation.

Industrial demand for groundwater is on the rise as a number of water intensive industries are steadily coming up in the area. It is recommended that extraction for industrial uses should be allowed only from the aquifer I and in no case from the aquifer II.

For the 1st Aquifer which is arsenic contaminated in its uppermost part, it is recommended to implement the use of solar photovoltaic groundwater pumping system with grounded tank for water storage developed for eastern India by the ICAR Research Complex for Eastern Region, Patna (Rahman and Bhatt, 2015). This technique has several advantages and the occurrence of shallow water level condition in the study area makes it more relevant. In addition to reduction in reliance on the fossil fuels for groundwater pumpage, this model may also be tested for the reduction in the arsenic load upon surface storage before being fed for irrigation.

Table 6.1: Requirement of water supply schemes from second aquifers for piped water supply in arsenic affected areas				
S. No.	**DISTRICT**	**BLOCK**	**Total population living in Arsenic affected Villages**	**No. of Water Supply Schemes required (for piped water supply) in As affected areas**
1	Begusarai	Bachhwara	43241	4
2	Begusarai	Barauni	95599	10
3	Samastipur	Mohanpur	40747	4
4	Samastipur	Mohiuddinagar	89005	9
5	Samastipur	Patori	37979	4
6	Samastipur	Vidyapati nagar	28872	3
7	Saran	Dighwara	28300	3
8	Saran	Sonepur	11328	1
9	Vaishali	Bidupur	76613	8
10	Vaishali	Desri	31923	3
11	Vaishali	Hajipur	117015	12
12	Vaishali	Raghopur	98128	10
13	Vaishali	Sahdai buzurg	29276	3
14	Patna	Bakhtiarpur	47667	5
15	Patna	Barh	36631	4
		TOTAL	**812324**	**81**

6.5 Suggested Plan for tal areas of Patna district

The tal lands in Patna district famously known as the Mokama group of tals are saucer shaped low-lying area separated from the river Ganga by its natural levee. This area gets inundated with the onset of monsoon. After late September water starts receding from higher niches to drain completely by the middle of December. The soils are grey, medium heavy-to-heavy in texture and very poor in drainage. Major crops in Tal lands are mostly Rabi season crops like lentil, lathyrus, and gram with no crop possible during Kharif due to submergence. The cultivated land under this segment is 30209.06 ha.

The tal areas are appropriately named as the ‘pulse bowl of Bihar’ though there is ample scope for increasing the productivity of these crops. Among the pulses, area under lentil (Masoor) is maximum followed by gram but this was in reverse order earlier, the reason for it can be attributed to the pest and theft problem in gram crop leading to uneconomical yields, ultimately leading to a major shift of the area under gram towards the lentil crop. Tal lands are another huge chunk of low lands in Patna district, which remains submerged during the Rainy season, but this area yields a bumper Rabi crop. Some summer crops are also cultivated in Tal areas on a very limited scale, with the help of shallow tube wells.

Due to submergence in the rainy season, the kharif crops are not sown in the tal areas. Rabi cultivation is based on the residual moisture of the land freed from submergence. When the drainage is delayed beyond 15th October, rabi sowing is delayed and the crops suffer due to loss of moisture during their maturity stage and lack of irrigation facility.

In view of the above facts, recharge shafts filled with granular materials may be constructed in the fields where the thickness of the top clay layer is upto 5-10 m below ground level and submergence upto 0.25-0.5 cm remains by the beginning of October. This will accelerate the vertical drainage and recharge to groundwater which is impeded because of the clayey nature of the soil. The design of a recharge shaft (2 m dia) for clearing 1 ha of land in ~20 days with an average inundation of 0.5 m is as under (fig 6.3).

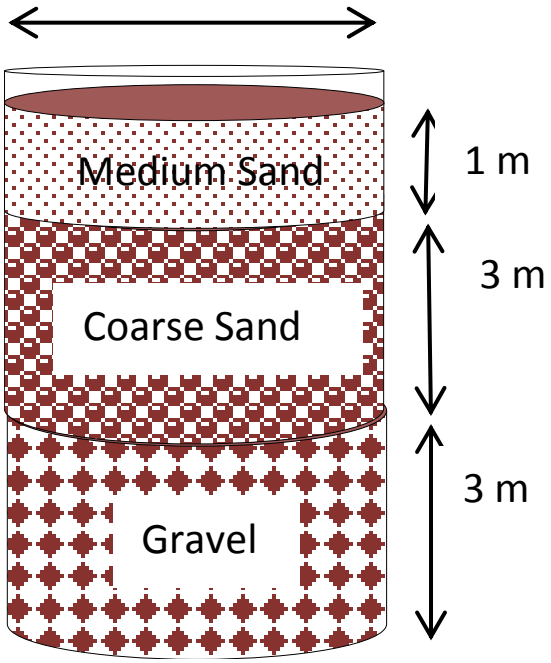


Fig 6.3 Design of recharge shaft for accelerated vertical recharge in tal areas

Annexure- I

Water level monitoring stations

Location	Block	long	lat	M.P (m agl)	Diameter (m)	Depth	water level(m bgl) June 2014	Nov-14
Rukunpura	Baktiyarpur	85.13737	25.62365	0.46	1.68	7.79	6.21	4.35
Bidhipur	Baktiyarpur	85.46111	25.49041	0.27	1.94	11.3	9.72	7.85
Alipur	Baktiyarpur	85.44178	25.47373	0.74	0.97	10.14	8.56	4.85
Hathia	Baktiyarpur	85.49639	25.49042	1.07	1.19	10.03	8.45	6.83
Benipur	Baktiyarpur	85.44611	25.50707	0.55	1.65	10.23	8.65	6.53
Malikpur	Raghopur	85.30997	25.5737	0.75	1.83	8.09	6.51	3.88
Jagdispur	Raghopur	85.33655	25.5737	0.76	1.67	7.69	6.11	3.62
Raghopur	Raghopur	85.38222	25.55705	0.62	2.26	8.69	7.11	4.08
jahangirpur	Sonepur	85.14828	25.72365	0.57	1.94	8.12	6.54	3.31
Govindchak	Sonepur	85.18478	25.74033	0.66	1.31	9.62	8.04	5.31
Naya Gaon	Sonepur	85.09828	25.77364	0.32	1.38	9.04	7.46	5.39
Sheetalpur	Dighwara	85.02886	25.75695	0.96	1.34	9.02	7.44	5.64
Syedpur	Dighwara	84.98281	25.75694	0.28	1.76	10.05	8.47	5.84
Dumari adda	Dighwara	84.87828	25.74024	0.53	2.1	8.61	7.03	6.07
Mahadipur	Dighwara	84.84181	25.74023	0.51	1.82	10.08	8.5	5.39
Inai	Revelganj	84.68114	25.79019	0.35	1.44	9.34	7.76	5.96
Revelganj	Revelganj	84.64442	25.79018	0.6	1.76	10.48	8.9	7.1
Shiv Nagari	Revelganj	84.77317	25.80688	0.5	2.15	6.97	5.39	4.35
Ambika Dwar	Dighwara	84.96878	25.75694	0.3	1.81	10.32	8.74	5.96
Rahimapur	Hajipur	85.23478	25.70701	0.52	2.27	8.16	6.58	4.28

Branti	Hajipur	85.31897	25.69037	0.35	1.27	8.06	6.48	4.1
Chakhamza	Bidupur	85.34608	25.69037	0.4	1.75	7.7	6.12	3.92
Chaksikandar	Bidupur	85.36233	25.69038	0.64	1.4	7.92	6.34	3.385
Uphraul chowk	Desri	85.41156	25.67373	0.78	1.85	8.84	7.26	4.84
Ram janki Math	Shahdei Buzurg	85.44294	25.70707	0.97	1.8	9.15	7.57	5.52
Jarpura	Patori	85.60781	25.67378	0.6	1.46	9.28	7.7	5.08
Chandan chowk	Patori	85.59656	25.64044	0.37	1.86	9.15	7.57	4.38
Andaur	Mohanpur	85.59294	25.65711	0.96	1.17	9.28	7.7	5.82
Kalyanpur Basti	Mohanpur	85.70667	25.60714	0.27	1.8	10.21	8.63	6.27
Bahadurpur	Baktiyarpur	85.4404	25.48	0.62	1.43	8.59	7.01	4.93
Karota	Baktiyarpur	85.4426	25.4708	0.53	1.4	6.72	5.14	3.88
Semariya/nauka tola	Revelganj	84.62417	25.80684	0.28	1.8	8.63	7.05	5.17
Rouza	Chapra Sadar	84.77892	25.79022	0.42	2.86	9.92	8.34	6.14
Nawada Khurd	Hajipur	85.16733	25.62366	0.55	1.8	10.56	8.98	6.28
Paikuli	Bidupur	85.28438	25.67369	0.99	1.69	10.15	8.57	6.01
Ramdauli	Bidupur	85.32975	25.65704	0.87	1.54	9.64	8.06	5.68
Khalsa Hasan Chauk	Bidupur	85.37797	25.64038	1.09	1.9	9.34	7.76	5.9
Khurampur	Desri	85.42865	25.6404	1.03	1.98	8.95	7.37	5.28
Sultanpur	Sahdei Bujurg	85.46362	25.64041	0.91	1.38	9.84	8.26	6.02
Mehnar	Mehnar	85.48057	25.62374	0.4	1.56	10.01	8.43	6.24
Simri	Vidyapati Nagar	85.76697	25.64049	0.52	2.58	8.14	6.56	4.43
Bangraha	Vidyapati Nagar	85.75108	25.64049	0.39	1.74	9.92	8.34	6.48
Khedarpur Chowk	Kancha	85.74703	25.67382	0.29	2.18	9.29	7.71	5.14
Navtola tare	Vidyapati Nagar	85.72858	25.62381	0.38	1.92	8.69	7.11	4.92
Hasanpur	Mohanpur	85.52239	25.60709	0.62	1.86	10.36	8.78	6.92
Chandanpur-Dhamaun	Patori	85.53794	25.59043	0.39	1.76	13.42	11.84	8.57

Mohanpur-dih	Mohanpur	85.58033	25.57377	0.49	2.27	6.34	4.76	3.78
Mohanpur	Mohanpur	85.58956	25.57377	0.34	2.26	10.01	8.43	6.21
Bingawan Dumri	Mohanpur	85.60556	25.57378	0.52	2.41	9.27	7.69	5.45
Sahit	Vidyapati Nagar	85.79672	25.60717	0.36	1.56	7.22	5.64	3.87

Annexure-II

Chemical analysis of groundwater sample of the study area.

SNo.	Location	Long	Lat	Block	District	Source	pH	EC	tds	CO3--	HCO3-	Cl-	F	SO42-	NO3-	TH	Ca2+	M
1	Gadi Mohanpur	85.5718	25.56817	Mohanpur	Samastipur	Handpump	7.37	602	385.28	0	244	21	1.16	40	0	235	20	
2	Mohanpur College Chauk	85.5839	25.56272	Mohanpur	Samastipur	Handpump	7.34	880	563.2	0	366	35	0.76	45	0	360	22	
3	Bhagara	85.5948	25.55994	Mohanpur	Samastipur	Handpump	7.27	803	513.92	0	293	21	0.9	45	0	245	50	
4	Bilgama	85.6139	25.56397	Mohanpur	Samastipur	Handpump	7.35	706	451.84	0	311	32	0.79	52	0	315	34	
5	Naya Tola Hasanpur	85.5352	25.58322	Mehnar	Vaishali	Handpump	7.4	804	514.56	0	250	21	0.95	21	0	115	14	
6	Hasanpur Tinmuhani	85.5239	25.58581	Mehnar	Vaishali	Handpump	7.6	1165	745.6	0	354	110	1.18	79	23.7	460	56	
7	Baghnoch	85.5176	25.59617	Mehnar	Vaishali	Handpump	7.56	774	495.36	0	329	35	0.77	18	23.8	295	18	
8	Lavapur Chauk	85.5036	25.60267	Mehnar	Vaishali	Handpump	7.65	855	547.2	0	397	28	1.06	20	11.1	365	16	
9	Mehnar	85.4796	25.61025	Mehnar	Vaishali	Handpump	7.29	1751	1120.64	0	598	110	0.84	94	25.3	600	22	
10	Thana More, Mehnar	85.4813	25.60892	Mehnar	Vaishali	Handpump	7.14	1920	1228.8	0	622	191	1.02	104	25.3	740	74	
11	Mehnar Thana	85.4814	25.60742	Mehnar	Vaishali	Handpump	7.68	783	501.12	0	378	11	1.15	41	0	310	16	
12	Malitola	85.4839	25.60481	Mehnar	Vaishali	Handpump	7.36	1465	937.6	0	561	106	1.19	105	25.2	500	54	
13	Ward No.11, Mehnar	85.4872	25.60326	Mehnar	Vaishali	Handpump	7.56	1343	859.52	0	439	135	0.89	120	25.1	560	64	
14	Ward No.10, FateHandpumpur kamali	85.4914	25.60169	Mehnar	Vaishali	Handpump	7.63	683	437.12	0	317	14	1	34	0	260	18	
15	Ward No. 10, FateHandpumpur Kamali	85.4927	25.60336	Mehnar	Vaishali	Handpump	7.81	578	369.92	0	256	18	0.93	28	0	205	22	
16	Maniyarpur	85.3938	25.62242	Biddupur	Vaishali	Handpump	7.22	719	460.16	0	317	18	0.75	37	0	260	20	
17	Near Kutubpur Chauk	85.3704	25.62606	Biddupur	Vaishali	Handpump	7.1	1321	845.44	0	409	138	0.45	96	24.6	555	62	
18	Opposite Biddupur Police Station	85.3329	25.64328	Biddupur	Vaishali	Handpump	7.96	732	468.48	0	336	21	0.83	49	0	245	18	
19	Ramnagar Diara	85°34′20.4′′	25°28′16.3′′	Athmalgola	Patna	Handpump	7.82	578	375.7	0	239.85	24.81	0.32	71.25	3.37	205	30	
20	Athmalgola	85°36′24.9′′	25°27′35.2′′	Athmalgola (As)	Patna	Handpump	8.2	721	468.65	0	270.6	99.26	1.07	33.17	4.05	195	24	
21	Surajpura	85°37′33′′	25°26′35′′	Athmalgola	Patna	Dugwell	8.4	1472	956.8	9	528.9	166.61	1.01	105.2	24.86	275	2	
22	Achuara	85°39′28.4′′	25°27′33.9′′	Athmalgola	Patna	Handpump	8.46	456	296.4	9	196.8	31.9	0.07	24.4	0	135	22	
23	Bariarpur	85°45′38.2′′	25°30′3.6′′	Pandarak	Patna	Handpump	8.22	718	466.7	0	319.8	85.08	1.17	11.03	0	65	8	
24	Raili	85°46′13′′	25°29′33.8′′	Pandarak	Patna	Handpump	7.36	666	432.9	0	252.15	106.35	1.04	12.5	0	75	14	
25	Meghagachi	85°47′42′′	25°29′5.4′′	Pandarak	Patna	Handpump	7.5	574	373.1	0	178.35	106.35	0.66	15.48	0	125	20	
26	Bampura	85°47′24.5′′	25°28′2.7′′	Pandarak	Patna	Dugwell	7.94	665	432.25	0	184.5	16.3	0.03	96.35	34.48	190	30	
27	Goasa	85°47′2.6′′	25°27′6.1′′	Pandarak	Patna	Handpump	8.21	395	256.75	0	196.8	24.81	0.66	21.46	0	90	34	

	SeikHandpumpura																	
28	Manjulabigha	85°46′30.8″	25°25′57.4″	Pandarak	Patna	Handpump	7.66	441	286.65	0	209.1	31.9	0.72	25.05	0	100	16	
29	Kondi	85°46′5″	25°25′1″	Pandarak	Patna	Handpump	8.11	408	265.2	0	209.1	17.72	0.91	22.21	0	100	16	
30	Chak Jalal	85°44′39″	25°23′36″	Pandarak	Patna	Handpump	8.02	434	282.1	0	233.7	24.81	0.51	28.67	0	120	18	
31	Ekdanga	85°42′27″	25°23′22.7″	Pandarak	Patna	Handpump	7.44	496	322.4	0	202.95	31.9	0.39	25.97	11.66	115	16	
32	Saksohra	85°42′2.1″	25°21′49.9″	Pandarak	Patna	Handpump	8.26	375	243.75	0	172.2	28.36	0.34	23.4	0	115	18	
33	Mubarakpur	85°43′59″	25°20′24″	Pandarak	Patna	Handpump	8.29	435	282.75	0	227.55	17.72	0.34	26.36	0	95	22	
34	Barwane	85°44′55.6″	25°20′0.1″	Pandarak	Patna	Dugwell	7..88	2482	1613.3	0	344.4	524.66	1.04	139.61	24.58	520	64	
35	Jagmal Chak	85°45′52.4″	25°19′34.5″	Pandarak	Patna	Handpump	8.18	476	309.4	0	221.4	24.81	0.27	34.14	0	170	16	
36	Pitunjia (As)	85°46′34.8″	25°20′12.5″	Pandarak	Patna	Handpump	7.56	357	232.05	0	221.4	3.54	0.95	4.62	0	95	12	
37	Sitarambaghi Kumhartola	85°48′47.7″	25°20′12.5″	Pandarak	Patna	Handpump	7.27	570	370.5	0	172.2	99.26	0.56	20.88	0	135	20	
38	Hathidah(AS)	85°59′7.3″	25°22′12.6″	Mokama	Patna	Handpump	7.41	385	250.25	0	209.1	14.18	0.62	20.4	0	100	16	
39	Goshain Gaon(As)	85°54′58″	25°22′53.3″	Mokama	Patna	Dugwell	8.31	1037	663.68	9	201	152	0.82	119	0	370	82	
40	Badpur	85°00′30.7″	25°19′56.9″	Mokama	Patna	Dugwell	8.38	1332	852.48	15	256	170	0.71	102	24.3	470	88	
41	Dariarpur tola	85°58′25.8″	25°22′52.2″	Mokama	Patna	Handpump	8.61	484	309.76	18	79	43	1	30	19.2	150	50	
42	Aunta	85°57′35.2″	25°23′7.4″	Mokama	Patna	Handpump	8.13	802	513.28	0	305	46	0.7	62	24	255	82	
43	Parshuramsthan	85°54′54.4″	25°23′57.2″	Mokama	Patna	Handpump	8.42	508	325.12	6	226	28	0.79	20	0	205	48	
44	Seonar	85°53′27″	25°24′33.3″	Mokama	Patna	Handpump	8.69	411	263.04	6	159	32	0.92	22	0	155	54	
45	Barahapur Bintoli	85°52′40.7″	25°25′11.8″	Mokama	Patna	Handpump	8.75	450	288	12	128	43	0.54	39	0	165	46	
46	Morh English(As)	85°52′6.6″	25°25′36.4″	Mokama	Patna	Handpump	8.57	529	338.56	3	134	50	0.58	51	24.1	200	60	
47	Sultanpur	85°51′24.5″	25°26′56.9″	Mokama	Patna	Dugwell	8.29	1496	957.44	0	329	227	1.1	110	0	445	52	
48	Kanhaipur	85°50′48.6″	25°27′46″	Mokama	Patna	Handpump	8.55	500	320	3	250	14	1.2	22	0	200	56	
49	Mekra	85°50′9.3″	25°28′29.2″	Mokama	Patna	Handpump	8.39	570	364.8	15	207	35	0.85	21	0	225	52	
50	Dahia	85°00′50.6″	25°32′18.1″	Bhagwanpur	Begusarai	Handpump	8.97	266	170.24	18	61	21	0.71	23	0	110	30	
51	Bhardiha	85°59′16.3″	25°32′57.2″	Bhagwanpur	Begusarai	Handpump	8.6	526	336.64	24	183	21	0.47	28	2.7	210	54	
52	Garhuni	85°57′35.4″	25°34′0.5″	Bhagwanpur	Begusarai	Handpump	8.9	446	285.44	27	134	21	1.17	23	0	125	36	
53	Manupur	85°57′35.4″	25°35′33.3″	Bhagwanpur	Begusarai	Handpump	8.85	510	326.4	30	140	21	0.47	43	24.4	205	34	
54	Dohta	85°59′22.8″	25°35′22.3″	Bhagwanpur	Begusarai	Handpump	8.1	1221	781.44	0	537	117	0.64	3	0	420	50	
55	JagdisHandpumpur	86°00′40.6″	25°34′45.8″	Bhagwanpur	Begusarai	Handpump	8.06	1270	812.8	0	354	163	1.4	111	0	490	32	
56	Sanjat (As)	86°01′3.4″	25°35′49.1″	Bhagwanpur	Begusarai	Handpump	8.54	455	291.2	9	195	14	1	23	0	200	52	
57	Tajpur	86°01′1″	25°34′17.1″	Bhagwanpur	Begusarai	Dugwell	8.4	1154	738.56	12	384	74	1.14	116	0	300	52	
58	Narharpur(As)	86°02′21″	25°34′23.1″	Bhagwanpur	Begusarai	Handpump	8.7	517	330.88	33	153	18	0.62	44	0	185	68	
59	Naula	86°03′55.5″	25°33′29.1″	Bhagwanpur	Begusarai	Handpump	8.33	1625	1040	18	677	135	1.2	36	0	525	40	
60	Pakdi	86°05′35.5″	25°32′1.5″	Birpur	Begusarai	Handpump	8.72	857	548.48	15	293	64	0.71	78	0	385	48	
61	Parra(As)	86°05′57.8″	25°29′42.6″	Birpur	Begusarai	Handpump	8.5	660	422.4	27	232	32	0.94	18	0	255	58	
62	Phulkari	86°06′17.2″	25°29′9.5″	Birpur	Begusarai	Handpump	8.65	524	335.36	27	214	14	1.29	14	0	235	36	
63	Kajichak	86°07′2.8″	25°28′8.2″	Birpur	Begusarai	Handpump	8.5	567	362.88	21	232	28	0.69	12	0	255	72	
64	Rajaura	86°08′49″	25°27′54.4″	Naokothi	Begusarai	Handpump	8.55	634	405.76	18	256	25	1.14	33	0	280	84	
65	Khamhar	86°08′44.4″	25°28′57.8″	Naokothi	Begusarai	Handpump	8.78	513	328.32	27	189	21	1.28	19	0	220	46	
66	Mohanpur(As)	86°07′54.5″	25°31′5.3″	Naokothi	Begusarai	Handpump	8.37	758	485.12	27	439	14	0.71	24	0	400	84	

67	Paharchak	86°08´28.4´´	25°26´33.5´´	Naokothi	Begusarai	Handpump	8.07	1010	646.4	0	488	46	0.29	17	0	425	96
68	Rukunpura	85.13737	25.62365	Bakhtiyarpur	Patna	Handpump	8.15	538	344.32	0	244	35.46	0.89	2.2	1.34	170	30
69	Bidhipur(Handpump)	85.46111	25.49041	Bakhtiyarpur	Patna	Handpump	8.35	517	330.88	24	231.8	21.276	0.59	3.6	0.14	175	24
70	Bidhipur(DG)	85.46111	25.49041	Bakhtiyarpur	Patna	Dugwell	8	1341	858.24	0	677.1	17.3754	0.6	34	39.07	410	56
71	Alipur	85.44178	25.47373	Bakhtiyarpur	Patna	Handpump	8.31	909	581.76	0	524.6	35.46	0.61	27	1.99	270	18
72	Hatia	85.49639	25.49042	Bakhtiyarpur	Patna	Handpump	8.22	804	514.56	0	207.4	70.92	0.52	52.92	38.97	205	38
73	Gyaspur	85.44611	25.50707	Bakhtiyarpur	Patna	Handpump	8.32	531	339.84	0	250.1	49.644	0.46	50.97	6.06	195	16
74	Malikpur(DG)	85.30997	25.5737	Raghopur	Vaishali	Dugwell	7.83	882	564.48	0	237.9	70.92	0.53	70.11	38.93	315	70
75	Jagdispur(Handpump)	85.33655	25.5737	Raghopur	Vaishali	Handpump	7.96	664	424.96	0	207.4	49.644	0.37	50.17	34.22	155	52
76	Raghopur(Handpump)	85.38222	25.55705	Raghopur	Vaishali	Handpump	8	690	441.6	0	231.8	35.46	0.34	41.72	28.13	260	60
77	Raghopur(DW)	85.38222	25.55705	Raghopur	Vaishali	Dugwell	8.18	379	242.56	0	201.3	10.638	0.44	14.21	2.69	175	50
78	Medanchowk	85.3242	25.5592	Raghopur	Vaishali	Handpump	8.01	747	478.08	0	250.1	67.374	0.28	77.37	7.49	300	38
79	Govindchowk	85.18478	25.74033	Sonepur	Saran	Handpump	7.98	1478	945.92	0	274.5	191.484	0.62	96.72	38.38	365	92
80	Sheetalpur	85.02886	25.75695	Dighwara	Saran	Handpump	8.3	532	340.48	18	244	14.184	0.5	42.68	0.59	210	24
81	Syedpur	84.98281	25.75694	Dighwara	Saran	Handpump	8.15	967	618.88	0	286.7	78.012	0.41	63.71	38.7	200	34
82	Mahadipur	84.84181	25.74023	Chapra	Saran	Handpump	8.04	1618	1035.52	0	402.6	209.214	0.67	129.42	38.98	535	54
83	Inai	84.68114	25.79019	Revelganj	Saran	Handpump	8.1	1514	968.96	0	433.1	205.668	0.6	122	7.37	400	38
84	Nagri gaon	84.77317	25.80688	Revelganj	Saran	Handpump	8.04	622	398.08	0	195.2	42.552	0.4	51.23	29.6	165	42
85	Nawada Khurd	85.16733	25.62366	Hajipur	Vaishali	Handpump	8.08	1475	944	0	353.8	173.754	0.78	99.76	38.05	405	78
86	Mahnar(DG)	85.48057	25.62374	Mehnar	Vaishali	Dugwell	8.11	980	627.2	0	244	85.104	0.6	82.43	35.12	160	42
87	Khurampur	85.42865	25.6404	Desri	Vaishali	Handpump	8.32	856	547.84	0.2	262.3	53.19	0.87	78.75	38.15	100	24
88	Khalsa chowk	85.37797	25.64038	Bidupur	Vaishali	Handpump	8.26	1328	849.92	0	341.6	109.926	0.75	132.47	8.88	335	30
89	Pakauli	85.28438	25.67369	Bidupur	Vaishali	Handpump	8.13	902	577.28	0	237.9	95.742	0.51	68.14	32.12	295	36
90	Rajpura	85.6426	25.4589	Barh	Patna	Dugwell	7.26	2450	1568	0	817	220	0.16	161	46	970	54
91	Acchuara	85.6551	25.4599	Barh	Patna	Handpump	8.55	443	283.52	3	116	32	0.25	41	19	90	10
92	Dahaur	85.6664	25.4617	Barh	Patna	Handpump	7.71	666	426.24	0	177	21	0.3	32	22	145	46
93	Alaknath (Chondi)	85.6985	25.4701	Barh	Patna	Handpump	8.57	479	306.56	9	195	53	0.04	10	0	115	10
94	Bajidpur	85.7081	25.4656	Barh	Patna	Dugwell	8.07	1532	980.48	0	384	188	0.73	87	43	445	30
95	Gulab-bagh	85.7167	25.4789	Barh	Patna	Handpump	8.39	565	361.6	6	201	64	0.3	27	0	155	20
96	Shahri	85.7284	25.4746	Barh	Patna	Handpump	8.51	808	517.12	9	293	92	0	47	0	260	18
97	Amarpur (Ranabigha)	85.736	25.4618	Barh	Patna	Dugwell	7.62	1386	887.04	0	378	131	0.28	68	44	460	66
98	Agwanpur	85.7317	25.4514	Barh	Patna	Dugwell	7.57	1887	1207.68	0	458	287	1.45	118	12	710	54
99	Agwanpur	85.7293	25.4524	Barh	Patna	Handpump	8.51	449	287.36	12	171	39	0.05	36	0	110	10
100	Jamunichak	85.7172	25.4599	Barh	Patna	Handpump	8.46	978	625.92	9	153	152	0.65	71	40	310	22
101	Kachahri Chowk	85.6924	25.4638	Barh	Patna	Handpump	8.64	610	390.4	12	159	64	0.39	60	1.6	160	16
102	Bachiari Malahi	85.6787	25.4618	Barh	Patna	Handpump	8.48	444	284.16	6	207	28	0.26	1.5	0	130	16
103	Hasan Chak	85.6488	25.4593	Barh	Patna	Handpump	8.59	482	308.48	12	183	25	0.51	36	2.7	105	8

Annexure-IIIa

As concentration ranges from 10 – 50 ppb

Sl. No	Location	Block	District	Latitude	Longitude	Type of well	Concentration (in ppb)
1	Maurah Toli chowk	Bachwara	Begusarai	25.59239	85.88353	TW	18.23
2	Rashidpur	Bachwara	Begusarai	25.63564	85.85669	TW	20.65
3	Barauni	Barauni	Begusarai	25.47158	86.03267	TW	13.80
4	Rajwara	Barauni	Begusarai	25.46472	86.00006	TW	15.97
5	Barauni Maa Durga Hall	Barauni	Begusarai	25.47008	86.98341	TW	12.54
6	Gahara	Barauni	Begusarai	25.45013	86.01494	TW	39.79
7	Badalpur Chowk	Barauni	Begusarai	25.45012	86.01503	TW	10.48
8	Naya Nagar,Dularpur	Teghra	Begusarai	25.51361	85.92417	TW	15.07
9	Krishna chauk More	Desri	Vaishali	25.66689	85.49306	TW	13.63
10	Tatma Toli	Shahdai Buzurg	Vaishali	25.66389	85.45019	TW	23.14
11	Malikpur	Raghopur	Vaishali	25.68750	85.45361	TW	22.19
12	Kabir chauraha	Raghopur	Vaishali	25.65583	85.36611	TW	16.60
13	Block office raghopur	Raghopur	Vaishali	25.56668	85.33354	TW	14.79
14	Fatehpur road	Raghopur	Vaishali	25.55023	85.33361	TW	22.03
15	policestation	Raghopur	Vaishali	25.56671	85.33352	TW	44.89
16	Rustampur	Raghopur	Vaishali	25.62389	85.284	TW	41
17	Maniarpur	Vidyapatinagar	Samastipur	25.64325	85.77864	TW	15.47
18	Chhapar	Mohiuddinnagar	Samastipur	25.55428	85.66814	TW	26.85
19	Kursaha	Mohiuddinnagar	Samastipur	25.55681	80.68164	TW	10.69
20	Dubaha paschim tola	Mohiuddinnagar	Samastipur	25.56986	80.72675	TW	32.33
21	Mohanpur	Mohanpur	Samastipur	25.56956	85.58639	TW	24.21
22	Rasalpur purvi	Mohanpur	Samastipur	25.55608	85.58047	TW	19.41

23	Ala Chowk	Mohanpur	Samastipur	25.55919	85.59694	TW	12.56
24	Dumri	Mohanpur	Samastipur	25.56028	85.60483	TW	36.55
25	Jalalpur	Mohanpur	Samastipur	25.55847	85.61425	TW	21.29

Annexure-IIIb

As concentration ranges from > 50 ppb

Sl. No	Location	Block	District	Latitude	Longitude	Type of well	Concentration (in ppb)
1	Marwa	Birpur	Bhagalpur	25.3988	86.9222	TW	140.01
2	Bihat	Barauni	Begusarai	25.45742	86.0138	TW	51.53

Annexure-IV

Location details of points where VES has been conducted

Dist	Block	Location	Long	Lat	Elvn (m)	AB (m)	r1	r2	r3	r4	r5	r6	r7	r8	h1	h2	h3	h4	h5	h6	h7	Depth	Topo sheet no
Samastipur	Mohanpur	dumri dakshin	25.54761	85.59558	40	460	29	72	38	54					2.6	10.6	115.5					128.7	72G/10
Samastipur	Mohiddinnager	jaunapur	25.53131	85.62614	34	460	100	350	56	100					2.7	14.6	118.3					135.5	72G/10
Samastipur	Mohiddinnager	ramchandrpur	25.56297	85.63608	31	520	34	30	217	50	143	32	1880		1.8	1.8	7.2	64	12.8	66		153.6	72G/10
Samastipur	Mohiddinnager	chaper	25.53886	85.65739	34	460	82	410	60	34	135				1.7	12	161	52.5				227.2	72G/10
Samastipur	Mohiddinnager	harail	25.56614	85.67161	28	520	62	19	65	45	132	22.4			1.5	3	12	18.2	22.4	38.8		95.9	72G/10
Samastipur	Patori	hetampur	25.58389	85.56136	34	460	42	294	62	34	100				2.7	4.05	37.8	161				205.6	72G/10
Samastipur	Patori	chaksima	25.61153	85.58047		520	18	9	18	13	27	21	52		1.65	1	2.79	15.2	4.2	92.4		155	72G/10
Samastipur	Patori	madhopur	25.58192	85.59019	36	520	19	57	29	67					1.8	27	192					220.8	72G/10
Saran	Chapra	salempur	25.73731	84.85917	41	600	15	12	32	21	74				1.6	2.88	13.5	82.5				100.5	72C/14
Saran	Chapra	badalpur	25.74478	84.81458	37	460	68	14	24	17	60				3.3	22.4	41.65	28.8				96.2	72C/14
Saran	Chapra	jp university campus	25.78094	84.77163	31	460	26	39	18	41					2.1	9.24	48					59.34	72C/13
Saran	Chapra	mathwalia	25.79975	84.68839	36	460	30	20	35	20	84				1.8	5.4	4.76	46.8				58.8	72G/9
Saran	Dariapur	Nizanchawk	25.78794	85.05728	51	520	21	13	30	35					1.7	4.76	72.8					79.26	72G/1
Saran	Dighwara	Sithapur Chatter Chappra	25.79064	85.03611	42	520	15	23	30	10	75	21			1.9	4.3	16	21.3	92			135.5	72G/1
Saran	Dighwara	dhigwara	25.75269	85.01536	33	460	15	51	25						4.9	161.7						166.6	72G/1
Saran	Dighwara	boddha chapra	25.74747	84.95456	37	460	8	20	75	43	230				3.6	10.08	55.1	40				108.8	72C/14
Saran	Dighwara	kam diara	25.73031	84.89433	45	520	140	350	22.4	41					2.45	15.9	166					184.4	72C/14
Saran	Sonpur	Sabbalpur	25.67756	85.18692		200																	72G/2
Saran	Sonpur	Sabbalpur Uttari	25.67964	85.16481	43	400	14	27	11	31	9				1.8	3.1	2.9	62.9				70.7	72G/2
Saran	Sonpur	Palehza	25.69531	85.14989	49	460	14	47	90						3	171						174	72G/2
Saran	Sonpur	Gangajal	25.70397	85.12764	42	520	15	38	50	24	48	25			1.15	1.73	27.2	41.6	112.5			184.53	72G/2

Saran	Sonpur	Gangajal	25.69753	85.12156	41	460																72G/2
Saran	Sonpur	Dumri	25.76936	85.08331	38	520	12	8	82	29	78				1.5	5.7	15.12	150.8				173.12	72G/1
Saran	Sonpur	Govindchowk	25.72456	85.13389	44	400	18	14	19	36	54				1.9	6.65	54.6	25.42				88.57	72G/2
Saran	Sonpur	Murthan	25.74308	85.13256	38	400	18	12	68	25					2.2	5.94	48					56.14	72G/2
Vaishali	Bidhupur	Kanpura	25.66628	85.23961	34	460	20	13	49	20	74	47			1.2	5.2	5	59.5	35.1			106	72G/6
Vaishali	Bidhupur	Saidpur Ganarh	25.66078	85.26097		600	16	13	21	10	24	22			1.2	2.2	22.1	39.2	27.7			92.4	72G/6
Vaishali	Bidhupur	Rahimapur	25.67261	85.27833	44	460	43	9	14	28	14				2.5	0.5	33.8	122.5				159.3	72G/6
Vaishali	Bidhupur	Doudnagar	25.66872	85.30572	50	520	6	21	9	28	26	50			1.22	1.53	1.64	9	94.54			107.93	72G/6
Vaishali	Bidhupur	Khitawal	25.64394	85.30606	40	460	24	12	27	14	63				1.52	6.23	19.2	37.2				64.15	72G/6
Vaishali	Bidhupur	Bidhupur	25.65814	85.32025	45	460	13	19.5	15.2	33					1.6	12.8	36.25					50.65	72G/6
Vaishali	Bidhupur	Bohuaza	25.69222	85.30753	36	200	9	22.5	45	25.6	72.5	18			1.25	6.5	16	19.5	20.7			64	72G/6
Vaishali	Bidhupur	Raghopur Chatrang	25.65219	85.34700	33	600	34	13.6	30	50					1.82	10.92	51.2					63.94	72G/6
Vaishali	Bidhupur	Harpur Gopal	25.65275	85.36822	45	520	21	13.65	50.75	14					1.5	42	110					153.5	72G/6
Vaishali	Bidhupur	Chechar	25.63300	85.37175	26	600	11	16.5	31	56	19	435			1.15	9.2	76.8	63.36	90			240.47	72G/6
Vaishali	Bidhupur	uproul kakrahat	25.67103	85.34956	23	520	47	19	58	17	33	18	58		2.3	6.7	5.5	21	67.2	96		198.7	72G/6
Vaishali	Bidhupur	kaly Anpur	25.67181	85.34033	32	600	31	39	19	58	35	28			1.3	4.81	7.44	30.8	168			212.4	72G/6
Vaishali	Bidhupur	chak Lalna	25.68231	85.32553	34	520	50	20	38	30	20				2.6	1.95	22.88	104.4				131.83	72G/6
Vaishali	Bidhupur	Mirapur	25.67067	85.22142	30	520	28	22	18	29					1.35	10.13	43					54.5	72G/6
Vaishali	Bidhupur	Gokulpur	25.59008	85.36133	31	400	70	350	88	61					1.4	7	27.5					35.9	72G/6
Vaishali	Dehri	Panapur	25.64342	85.39528	29	400	27	10.8	38.5						1.8	30.6						32.4	72G/6
Vaishali	Dehri	Mustafapur	25.62814	85.39019	26	600	8.2	12.3	22	45	20	170			1.45	6.53	24	150.4	44			226.4	72G/6
Vaishali	Dehri	Maniharpur	25.61083	85.39242	19	600	15	6	9	42.5	13	760			1.8	6.3	18.02	67.5	102			195.6	72G/6
Vaishali	Dehri	Babangama	25.62119	85.41294	27	460	57	86	65	42					1.32	8.6	78.8					88.7	72G/6
Vaishali	Dehri	Jahangirpur	25.61411	85.41106	21	200																	72G/6
Vaishali	Dehri	chak Mahammadpur	25.67006	85.39939	25	520	68	34	15	50	21	56			1.34	3	5.6	46	62.1			118.3	72G/6
Vaishali	Dehri	Madhoul	25.65233	85.41450	34	520	42	13	22	29					2.1	10	36					48.1	72G/6
Vaishali	Dehri	Talia	25.68809	85.38550	34	460	43	22	63	37	25				3.4	9.2	24	155.1				192	72G/6

Vaishali	Dehri	Upkroul	25.68736	85.42286	27	460	26	13	43	29	27	34			2	1.6	16.7	20	77.4			117.7	72G/6
Vaishali	Hazipur	Terasia	25.64811	85.21044	36	460	65	81	41						1.35	28.35						29.7	72G/6
Vaishali	Hazipur	sultanpur	25.69139	85.25514	42	600	24	19	25	28	41				1.7	6.8	6.1	57				71.6	72G/6
Vaishali	Hazipur	chak ashi	25.68314	85.28975	42	600	27	11	24	29					1.92	7.7	16					25.6	72G/6
Vaishali	Hazipur	chak yari	25.70239	85.28089	33	460	61	24	68	31	190	42	18		2.7	3	5.4	13.5	8.4	80		113	72G/6
Vaishali	Hazipur	Panapur langa	25.72317	85.27522	31	460	49	25	68	27	15				2.3	10.8	10.4	84				107.5	72G/6
Vaishali	Hazipur	Subhai	25.72058	85.24650	37	160																	72G/2
Vaishali	Hazipur	Daulatpur	25.72769	85.23803	36	400	54	11	55	33					1.6	0.96	262.5					265.1	72G/2
Vaishali	Hazipur	Harsarganj	25.71289	85.20819	40	320	10	6.5	27	65	13				1.7	2.6	11	39.6				54.9	72G/2
Vaishali	Hazipur	Ghouspur	25.74231	85.21242	28	600	39	31	64	23	27				1.6	7.2	44.7	18				71.5	72G/2
Vaishali	Hazipur	Akhilabad	25.72756	85.19328	26	600	36	29	60	32	16				1.7	6.8	4.9	135				148.4	72G/2
Vaishali	Hazipur	Manua	25.75214	85.20711	33	600	43	22	47	30	40	114			1.4	8.4	20.24	84	62.56			175.96	72G/1
Vaishali	Mahnar	sultanpur	25.61686	85.46244	34	460	29	17	48	16	58	29			1.2	9.12	5.25	7.8	121.5			144.8	72G/6
Vaishali	Raghopur	Diwantak	25.64658	85.24781	35	600	58	1160	94	21	75	41	38	105	1.3	0.62	13.34	7	33.6	69.44	100	225.28	72G/6
Vaishali	Raghopur	Terasia	25.64389	85.21978	44	460	72	252	30	20					1.6	7.2	35.65					44.45	72G/6
Vaishali	Raghopur	Sabbalpur	25.62883	85.22261	45	460	47	118	21	32	72				1.6	13.6	1.75	94.4				111.3	72G/6
Vaishali	Raghopur	Saidebad	25.54258	85.29056	40	600	49	245	69	46	70	39			2	2.35	28.6	87.5	72			192.5	72G/6
Vaishali	Raghopur	Saidebad	25.54972	85.31767	29	600	84	126	48	84	53	90	42		2	8.4	69.8	49.4	87.8	55		272.4	72G/6
Vaishali	Raghopur	Chandpura	25.54997	85.34394	29	600	30	105	93	53	40				2.2	3.96	40.5	240				286.7	72G/6
Vaishali	Raghopur	Paharpur	25.54886	85.36453	28	520	28	280	51						2.5	17.5						20	72G/6
Vaishali	Raghopur	Fatehpur	25.57267	85.34883	35	520	43	151	65	48					3	7.8	31.5					42.3	72G/6
Vaishali	Sahdal Buzurg	Tariapur	25.62183	85.44256	31	600	17	11	20	14	43	23	65		1.65	2.5	5	11	46.5	100		166.65	72G/6
Vaishali	Sahdal Buzurg	Wajijpur	25.64767	85.44839	35	520	58	17	15	25	58				1.4	12.6	16.3	112				142.3	72G/6
Vaishali	Sahdal Buzurg	Ramganj	25.66583	85.45942	27	600	23	15	23	14	27				1.9	3.6	13.7	14.6				33.8	72G/6

Annexure-V

National aquifer mapping (NAM) exploration details

(as per 12 point progress format in Aquifer Mapping manual)

1. FORMAT FOR LITHOLOG

Unique ID	
Village	Gyaspur
Taluka/Block	Bakhtiyarpur
District	Patna
Toposheet No.	72G/7
Lat	25.4737
Long	85.4689
RL (m amsl)	
Drilled Depth	250
Casing	194
SWL (m bgl)	2.69
Discharge (lps)	54.06
Date/Year	March 2006

Depth range (m bgl)		**Thickness (m)**	**Litholog**
From	**To**		
0	25	25	Silt with fine sand, brown in colour
25	41	16	Fine to medium sand, grey colour
41	54	13	Medium to coarse sand, grey colour
54	82	28	Coarse sand with occasional gravel beds, grey colour
82	88	6	Clay sand with thin beds of fine sand, grey colour
88	223	135	Coarse to very coarse sand with gravel, grey colour
223	230	7	Medium to coarse sand with occasional gravels, grey colour
230	250	20	Coarse to very coarse sand with gravels, grey colour

2. FORMAT FOR LITHOLOG

Unique ID	
Village	Barh
Taluka/Block	Barh
District	Patna
Toposheet No.	72G/11
Lat	25.4735
Long	85.6919
RL (m amsl)	
Drilled Depth	274
Casing	230
SWL (m bgl)	4.4
Discharge (lps)	53.13
Date/Year	October 2006

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	7	7	Clay, brown colour
7	13	6	Clay, black colour
13	33	20	Medium to coarse sand, light brown colour
33	38.5	5.5	Fine to medium sand with gravels and calcareous nodules, light grey colour
38.5	51	12.5	Fine to medium sand with gravels, calcareous and iron nodules, light grey
51	66	15	Medium to coarse sand with gravels, calcareous and iron nodules, light grey
66	103	37	Rock fragments mixed medium to coarse sand, light grey
103	109	6	Clay
109	126	17	Fine to medium sand with minor gravels, iron nodules, light brown colour
126	133	7	Fine to medium sand with calcareous material, light grey colour
133	150	17	Medium to coarse sand with calcareous material, light grey colour
150	162	12	Fine to medium sand, light grey colour
162	183	21	Medium to coarse sand with occasional gravels and calcareous materials, light grey colour
183	186	3	Silt sand, grey colour
186	196	10	Fine to medium sand with gravels, calcareous materials and iron nodules, grey colour
196	202	6	Fine to medium sand, grey colour
202	227	25	Medium to coarse sand with calcareous materials and gravels
227	257	30	Rock fragments with medium to coarse sand, grey colour
257	274	17	Medium to coarse sand with calcareous nodules, grey colour

3. FORMAT FOR LITHOLOG

Unique ID	
Village	Konhara Ghat
Taluka/Block	Hajipur
District	Vaishali
Toposheet No.	72G/2
Lat	25.724
Long	85.1996
RL (m amsl)	
Drilled Depth	300.15
Casing	
SWL (m bgl)	12.98
Discharge (lps)	176.2

Date/Year	-

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	7.15	7.15	Pieces of bricks
7.15	13.65	6.5	Clay, Sticky, reddish pink in colour
13.65	20.15	6.5	Clay with some calcareous nodules, pink in colour
20.15	26.65	6.5	Clay with fine to medium sand, light pink in colour
26.65	46.15	19.5	Clay with pieces of calcareous nodules, yellow in colour
46.15	56.15	10	Clay with frequent calcareous nodules, light yellow in colour
56.15	65.65	9.5	Sand, coarse grained with few gravels, sub angular. Little clay parting is present . light yellow in colour
65.65	72.15	6.5	Sand, coarse grained, sub-angular with non-plastic clay. Light brown in colour
72.15	85.15	13	Sand, medium to coarse, sub-angular with little clay. Light brown in colour
85.15	98.15	13	Sand, coarse grained with gravels, sub-angular. Brownish yellow in colour
98.15	130.65	32.5	Sand, coarse grained with gravels, sub-angular. Brownish yellow in colour
130.65	150.15	19.5	Sand, coarse grained with gravels, sub-angular. Light colour
150.15	163.15	13	Sand, coarse grained, gravels, sub-angular. Brownish little dark in colour
163.15	195.65	32.5	Clay, non-sticky, yellowish in colour
195.65	218.65	23	Clay with fine sand and some calcareous nodules. Light grey in colour
218.65	228.15	9.5	Sand, medium to coarse grained , sub-angular with clay parting. Grey in colour
228.15	247.65	19.5	Sand, coarse grained gravels with some calcareous nodules. Little clay is present. Yellow colour
247.65	254.15	6.5	Sand, coarse grained with some gravels and mud partings. Yellow colour
254.15	266.15	12	Clay, fine in nature with kankars. Grey colour
266.15	293.15	27	Clay with kankars. Yellow colour
293.15	300.15	7	Clay, grey in colour

4. FORMAT FOR LITHOLOG

Unique ID	
Village	Shahpur Patori
Taluka/Block	Patori
District	Samastipur
Toposheet No.	72G/10

Lat	25.6261
Long	85.5599
RL (m amsl)	
Drilled Depth	235
Casing	
SWL (m bgl)	3.85
Discharge (lps)	54.03
Date/Year	November 2008

Depth range (m bgl)		**Thickness (m)**	**Litholog**
From	**To**		
0	5.5	5.5	Clay, black, thick, sticky
5.5	14.5	9	Clay, brown, thick, stiky
14.5	39.5	25	Pebble, coarse to medium grained, brown, irregular mixed with medium grained rock fragments
39.5	64.5	25	Clay, brown, thick, mixed with coarse grained rock fragments
64.5	74	9.5	Pebbles, black, coarse grained, irregular, mixed with coarse grained rock fragments
74	77	3	Sand, medium to fine grained, mixed with coarse grained pebbles of black color, irregular in size
77	83.25	6.25	Sand, medium to fine grained , mixes with medium to coarse grained black colored pebbles, irregular in size
83.25	95.75	12.5	Sand, medium to fine grained, mixed with medium to coarse grained brown colored pebbles
95.75	108.25	12.5	Sand, medium to fine grained
108.25	114.5	6.25	Pebbles, black, medium grained, mixed with medium to fine grained sand
114.5	120.75	6.25	Pebbles, black, medium grained, mixed with medium quartz
120.75	127	6.25	Clay, soft, light brown
127	133.25	6.25	Pebbles, medium grained, brown, mixed with quartz
133.5	152	18.75	Clay, soft, light brown
152	158.25	6.25	Pebbles, brown, medium grained, irregular
158.25	177	18.75	Clay, black thick
177	202	25	Clay , brown thick
202	208.25	6.25	Sand, medium to fine grained, mixed with medium grained pebbles
208.25	235	26.75	Clay, brown, medium soft

5. FORMAT FOR LITHOLOG

Unique ID	
Village	Vidyapati Nagar
Taluka/Block	Vidyapati Nagar
District	Samastipur
Toposheet No.	
Lat	25.6011
Long	85.7984
RL (m amsl)	
Drilled Depth	235
Casing	225
SWL (m bgl)	5.78
Discharge (lps)	15.77
Date/Year	August 2007

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	32	32	Clay
32	35	3	Fine sand
35	44	9	Sandy clay
44	46	2	Fine sand
46	64	18	Medium to coarse sand
64	84	20	Coarse sand with gravels
81	85	4	Medium to Coarse sand
85	87	2	Sticky clay
87	92	5	Sandy clay with gravels
92	94	2	Fine sand
94	96	2	Sandy clay
96	98	2	Fine sand
98	108	10	Coarse sand
108	130	22	Medium to coarse sand
130	132	2	Sandy clay
132	143	11	Sticky clay
143	147	4	Fine sand with gravels
147	149	2	Sticky clay
149	154	5	Coarse sand with gravels
154	169	15	Sticky clay
169	177	8	Sandy clay
177	184	7	Medium to coarse sand
184	194	10	Clay
194	201	7	Sandy clay
201	207	6	Fine sand
207	224	17	Fine to medium sand
224	228	4	Clay with gravels
228	235	7	Sandy clay

6. FORMAT FOR LITHOLOG

Unique ID	
Village	Madudabad
Taluka/Block	Mohinuddin Nagar
District	Samastipur
Toposheet No.	
Lat	25.5862
Long	85.7285
RL (m amsl)	
Drilled Depth	302
Casing	232
SWL (m bgl)	3.71
Discharge (lps)	57.78
Date/Year	February 2007

Depth range (m bgl)		**Thickness (m)**	**Litholog**
From	**To**		
0	13.8	13.8	Black clay
13.8	25	11.2	Fine to medium sand, light grey colour
25	35	10	Fine to medium sand. Yellow colour
35	42	7	Medium to coarse sand with pebbles, yellow colour
42	45	3	Sandy clay
45	64	19	Fine to medium sand, yellow colour
64	82	18	Medium to coarse sand yellow colour
82	96	14	Coarse sand with gravels, yellow colour
96	137	41	Coarse sand, yellow colour
137	144	7	Medium to coarse sand, light yellow colour
144	169	25	Clayey sand, yellow colour
169	184	15	Fine sand, light yellow colour
184	198	14	Clay bed
198	217	19	Sandy clay, light yellow colour
217	221	4	Fine to medium sand, light grey colour
221	232	11	Coarse sand with gravels, light colour
232	302	70	Clay with occasional thin sand beds, light yellow colour

7. FORMAT FOR LITHOLOG

Unique ID	
Village	Gangajal
Taluka/Block	Sonepur
District	Saran
Toposheet No.	72G/2
Lat	25.7102
Long	85.161
RL (m amsl)	
Drilled Depth	196.7
Casing	175
SWL (m bgl)	
Discharge (lps)	
Date/Year	September 2008

Depth range (m bgl)		**Thickness (m)**	**Litholog**
From	**To**		
0	6.5	6.5	Top soil with fine sand mixed with clay
6.5	25	18.5	Kankar with fine to medium sand
25	34.68	9.68	Fine clay (Yellow) mixed with Fine to Medium sand
34.68	40.91	6.23	Yellow clay mixed with fine sand
40.91	47.14	6.23	Yellow clay mixed with fine sand
47.14	53.38	6.24	Yellow clay, fin sand, medium sand and kankar
53.38	72.06	18.68	Medium sand mixed with kankar nodules
72.06	156.05	83.99	Fine to medium sand few percentage of Kankar
156.05	168.59	12.54	Fine sand mixed little clay (yellow)
168.59	174.81	6.22	Fine sand yellow colour
174.81	187.24	12.43	Light grey colour fine sand with kankar
187.24	196.7	9.46	Fine sand light colour mixed with clay

8. FORMAT FOR LITHOLOG

Unique ID	
Village	Narepur
Taluka/Block	Bachwara
District	Begusarai
Toposheet No.	
Lat	25.5947
Long	85.9164
RL (m amsl)	
Drilled Depth	278.75
Casing	

SWL (m bgl)	5.23
Discharge (lps)	23.4
Date/Year	March 2009

Depth range (m bgl)		**Thickness (m)**	**Litholog**
From	**To**		
0	13.25	13.25	Black non sticky clay
13.25	19.5	6	Medium sand
19.5	25.75	6.25	Clay mixed with medium to coarse sand
25.75	39	13.25	Fine to medium sand
39	50	11	Medium to coarse sand
50	69.5	19.5	Coarse kanker with quartz
69.5	82	12.5	Gray sand with coarse pieces
82	92	10	Clay with pieces of kankar
92	100.75	8.75	Coarse gray colour kankar
100.75	113.25	12.5	Medium to coarse sand with gray in colour
113.25	129	15.75	Medium to coarse clean sand
129	150	21	Broun colour clay with kankar
150	194.25	44.25	Sticky clay
194.25	209.75	15.5	Black sticky clay
209.75	222.25	12.5	Medium to coarse sand
222.25	234.75	12.5	Fine to medium sand
234.75	241	6.25	Brown clay
241	259.75	18.75	Clay mixed with fine sand
259.75	278.75	19	Clay yellowish in colour

9 FORMAT FOR LITHOLOG

Unique ID	
Village	Barauni Flag
Taluka/Block	Bachwara
District	Begusarai
Toposheet No.	
Lat	25.4643
Long	85.965

RL (m amsl)	
Drilled Depth	
Casing	253
SWL (m bgl)	5.23
Discharge (lps)	49.86
Date/Year	November 2009

Depth range (m bgl)		**Thickness (m)**	**Litholog**
From	**To**		
0	5.5	5.5	**Clay**, Surface clay, non sticky, gray colour
5.5	7.5	2	**Mix zone**, Clayey sand, gray in colour
7.5	15.5	8	**Mix zone**, Sandy clay, gray in colour
15.5	21.25	5.75	Clay, gray in colour
21.25	27.5	6.25	**Sand**, Micaceous fine sand (typical present day Ganga sand), gray in colour
27.5	33.75	6.25	**Sand**, Medium to coarse, brownish yellow sand with kankars
33.75	46.25	12.5	**Sand**, Fine to medium brownish yellow sand with kankars.
46.25	52.5	6.25	**Sand**, Medium to coarse, brownish yellow sand with kankars
52.5	58.75	6.25	**Sand**, Coarse brownish yellow sand with kankars
58.75	65	6.25	**Sand**, Fine brownish yellow sand with kankars
65	90	25	**Sand**, Fine to coarse brownish yellow sand with the predominance of medium to coarse sands. Still coarse to gravel size kankars dominate over sands.
90	112	22	**Sand**, Medium to coarse brownish yellow sands predominate with coarse to gravel size kankars and fine sand admixture.
112	118.25	6.25	**Sand**, Fine to medium brownish yellow sand with few kankars and coarse sands.
118.25	124.5	6.25	**Sand**, Fine to medium brownish yellow sand with greater proportion of kankars.
124.5	127.5	3	**Sand**, Fine to medium brownish yellow sand with few kankars and coarse sands.
127.5	146.25	18.75	**Sand**, Fine to medium brownish yellow sand with

			greater proportion of kankars and coarse sands.
146.25	155.75	9.5	**Sand**, Fine to medium brownish yellow sand with medium sand predominating, less kankars. Coarse sands are basically sub-angular in nature.
155.75	165	9.25	**Sand**, Medium to coarse brownish yellow sand with less kankars.
165	187.75	22.75	**Sand**, Medium to coarse brownish yellow sand with more gravel size kankars.
187.75	233.75	46	**Sand**, Medium to coarse sand. Colour of sands changes with a more yellowish red tint on sands (basically feldspars). Polished, sub-rounded to rounded coarse (few gravels) grains present. Kankar proportion is minor.
233.75	246.25	12.5	**Sand**, Fine to medium brownish yellow sand with less kankars. Again sediment nature changes to the earlier position.
246.25	252.5	6.25	**Sand**, Fine to medium (mediums less) brownish yellow sand with less kankars.

10 FORMAT FOR LITHOLOG

Unique ID	
Village	Teghra
Taluka/Block	Teghra
District	Begusarai
Toposheet No.	
Lat	25.4946
Long	85.9344
RL (m amsl)	
Drilled Depth	146.25
Casing	
SWL (m bgl)	5.61
Discharge (lps)	58.61
Date/Year	June 2010

Depth range (m bgl)		**Thickness (m)**	**Litholog**
From	**To**		
0	7.5	7.5	Clay, deep brown to gray in colour
7.5	11.5	4	Fine to very fine gray, micaceous sand with silt
11.5	15	3.5	Fine gray, micaceous sand

15	18.25	3.25	Very fine gray, micaceous sand
18.25	30.75	12.5	Fine gray, micaceous sand
30.75	31.5	0.75	Clay, deep gray in colour
31.5	33.75	2.25	Medium to coarse, yellowish brown sand with kankars and iron flakes
33.75	46.25	12.5	Fine to medium, brownish yellow sand with kankars, iron flakes and biotite fines.
46.25	58.75	12.5	Medium, brownish yellow sand with few kankars and biotite fines.
58.75	71.25	12.5	Fine to medium, brownish yellow sand with kankars, iron flakes and biotite fines.
71.25	83.75	12.5	Medium, brownish yellow sand with few kankars and biotite fines.
83.75	90	6.25	Medium to coarse, yellowish brown sand with high percentage of kankars.
90	91	1	Clay
91	105.75	14.75	Medium to coarse, yellowish brown sand with high percentage of gravelly kankars, quartz and feldspars.
105.75	121.25	15.5	Medium to coarse, yellowish brown sand with low percentage of kankars, quartz and feldspars.
121.25	127.5	6.25	Medium to coarse, yellowish brown sand with low percentage of kankars, quartz and feldspars. Thin lenses of clay seem to intersperse the formation.
127.5	146.25	18.75	Medium to coarse, yellowish brown sand with low percentage of kankars, quartz and feldspars.

Khagaul

Lithology	**Depth Range (m bgl)**	**Thickness (m)**
Clay	0 -3.5	3.5
Fine to Medium Sand	3.5 -13.2	9.7
Clay	13.2 -25.9	12.7
Sandy Clay	25.9 -45	19.1
Coarse Sand	45 -113	68

Clay	113 -122	9
Coarse Sand	122 -147	25
Clay	147 -156	9
Coarse Sand	156 -167	11
Clay	167 -177	10
Coarse Sand	177 -225	48
Fine to Medium Sand	225 -262.27	37.27

A.N.College Campu,Patna

Lithology	**Depth Range (m bgl)**	**Thickness (m)**
Sandy Clay	0 -30	30
Coarse Sand	30 -69	39
Clay	69 -88	19
Fine to Medium Sand	88 -94	6
Sandy Clay	94 -118	24
Fine to Medium Sand	118 -185	67
Coarse Sand	185 -230	45
Clay	230 -235	5
Coarse Sand	235 -245	10
Clay	245 -300	55

Mithapur

Lithology	**Depth Range (m bgl)**	**Thickness (m)**
Clay	0 -22	22
Coarse Sand	22 -27	5
Clay	27 -77	50
Fine to Medium Sand	77 -104	27
Clay	104 -109	5
Fine to Medium Sand	109 -247	138

Kadamkuwa

Lithology	**Depth Range (m bgl)**	**Thickness (m)**
Clay	0 -13.3	13.3
Coarse Sand	13.3 -35.5	22.2
Clay	35.5 -54.4	18.9
Coarse Sand	54.4 -57.4	3

Clay	57.4 -63.7	6.3
Coarse Sand	63.7 -70	6.3
Clay	70 -73.5	3.5
Coarse Sand	73.5 -82.6	9.1
Gravel	82.6 -88.9	6.3
Clay	88.9 -95.2	6.3
Gravel	95.2 -101.8	6.6
Coarse Sand	101.8 -191	89.2
Medium Sand	191 -228.8	37.8
Clay	228.8 -251.7	22.9

Phulwarisarif

Lithology	**Depth Range (m bgl)**	**Thickness (m)**
Sandy Clay	0 -43.82	43.82
Medium Sand	43.82 -118.56	74.74
Coarse Sand	118.56 -137.26	18.7
Medium Sand	137.26 -230.62	93.36

Bihata

Lithology	**Depth Range (m bgl)**	**Thickness (m)**
Fine to Medium Sand	0 -7	7
Sandy Clay	7 -31	24
Coarse Sand	31 -87	56
Clay	87 -106	19
Fine to Medium Sand	106 -129	23
Sandy Clay	129 -175	46
Fine to Medium Sand	175 -250	75

Annexure VI

Dynamic Ground Water Resources of Blocks taken under Phase II

Sl. No.	Block	District	Recharge n Rainfall during onsoon season	Recha from her urces ring nsoon ason	Recharge m Rainfall uring non-soon season	Recharge om other rces during n- monsoon season	Total Annual Ground Water echarge	Provision Natural scharge	Net Annual Ground Water ailability	Existing ross Ground ter Draft for Irrigation	Existing Gross ound water Draft r Domestic and dustrial Water Supply	Existing ross Ground ter Draft For Uses (10+11)	Allocation Domestic Industrial quirement pply upto ear 2025	Net Ground er Availability for ture irrigation velopment (9-10-13)	Stage of round Water elopment (%)	Category: Safe / i-critical/ Critical/ Over-exploited
1	Bachhawara	Begusarai	3767	322	551	599	5238	524	4714	3101	310	3411	531	1082	72.4	Safe
2	Bhagwanpur	Begusarai	2952	195	432	363	3942	394	3548	1859	265	2123	453	1237	59.8	Safe
3	Birpur	Begusarai	1344	157	197	293	1991	199	1792	1506	150	1656	258	29	92.4	**Semi-critical**
4	Naokothi	Begusarai	1371	171	201	318	2061	206	1855	1646	162	1808	278	-68	97.5	**Semi-critical**
5	Teghra	Begusarai	3767	157	551	291	4766	477	4290	1502	426	1928	730	2058	45	Safe
6	Mohanpur	Samastipur	1949	120	333	89	2491	125	2366	621	171	793	272	1473	33.5	Safe
7	Mohiaddina	Samastipur	3385	336	533	248	4502	225	4277	1739	358	2096	637	1901	49.0	Safe
8	Patori	Samastipur	3105	196	441	145	3887	194	3693	1015	277	1292	440	2238	35.0	Safe
9	Vidyapatina	Samastipur	2406	324	360	239	3328	333	2995	1674	236	1910	374	947	63.8	Safe
10	Biddupur	Vaishali	2530	1864	421	3178	7992	400	7593	2369	382	2751	562	4662	36.2	Safe
11	Hazipur	Vaishali	2657	421	363	323	3765	377	3389	2221	249	2471	367	800	72.9	Safe
12	Mahnar	Vaishali	4070	456	556	350	5432	543	4889	2414	512	2926	561	1914	59.8	Safe
13	Raghopur	Vaishali	6068	493	830	378	7769	777	6992	2609	346	2954	509	3875	42.2	Safe
14	Sahdai urg	Vaishali	2358	272	322	209	3161	316	2845	1439	183	1622	269	1136	57	Safe
15	Desri/Premraj	Desri/Premraj	1993	183	619	272	2588	259	2329	962	137	1099	202	1165	47.2	Safe
15	Dighwara	Saran	2025.8	219	274	247.3	2765.8	138	2628	1472	287	1759	363	793	66.9	Safe
16	Sonpur	Saran	3283.5	156	517.5	175.9	4132.9	207	3926	1050	513	1564	683	2192	39.8	Safe

17	Chapra	Saran	4387.6	534	569.8	507.7	5998.9	600	5399	2192	610	2802	782	2425	51.9	Safe
18	Revelganj	Saran	2931.3	189	380.7	213.5	3714.8	371	3343	1275	292	1566	355	1713	46.8	Safe
19	Athmalgol	Patna	986	242	130	82	1441	144	1296	835	123	958	172	290	73.9	Safe
20	Bakhtiapur	Patna	4822	483	637	165	6106	611	5496	1700	482	2182	479	3317	39.7	Safe
21	Barh	Patna	2685	374	354	127	3540	354	3186	1332	307	1639	479	1375	51.4	Safe
22	Mokama	Patna	4687	368	619	125	5799	580	5219	1319	606	1925	1042	2858	36.9	Safe
23	Pandarak	Patna	5020	661	663	225	6568	657	5912	2361	220	2581	306	3244	43.7	Safe

Block wise
Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km^2)
Athmalgola

District/ State
PatnaBihar/

Rainfall

The normal annual rainfall of Patna district is 988mm of which %86 occurs during the monsoon season. The normal rainfall during monsoon season is 855mm and during non-monsoon season is 133mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice- Wheat, Rice-Gram, Rice- lentil and Rice- Rai. The soils in this zone are sandy loam, clay loam, laom and clay with pH in the range of 6.8-8. The variation of rainfall in this zone is from 990 mm to 1240 mm and the temperature varies from 37.1 to 7.8˚C.

Ground water resource availability and extraction

The dynamic ground water resource of Athmalgola Block has been assessed as 12.96 MCM. The gross ground water draft for all uses stands at 9.58 MCM. The stage of Development is 73.9%(Annexure I) .

Water level behavior

The depth to water level varies from 8m to mbgl 10 during the pre-monsoon season and from 6 to 10 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below.

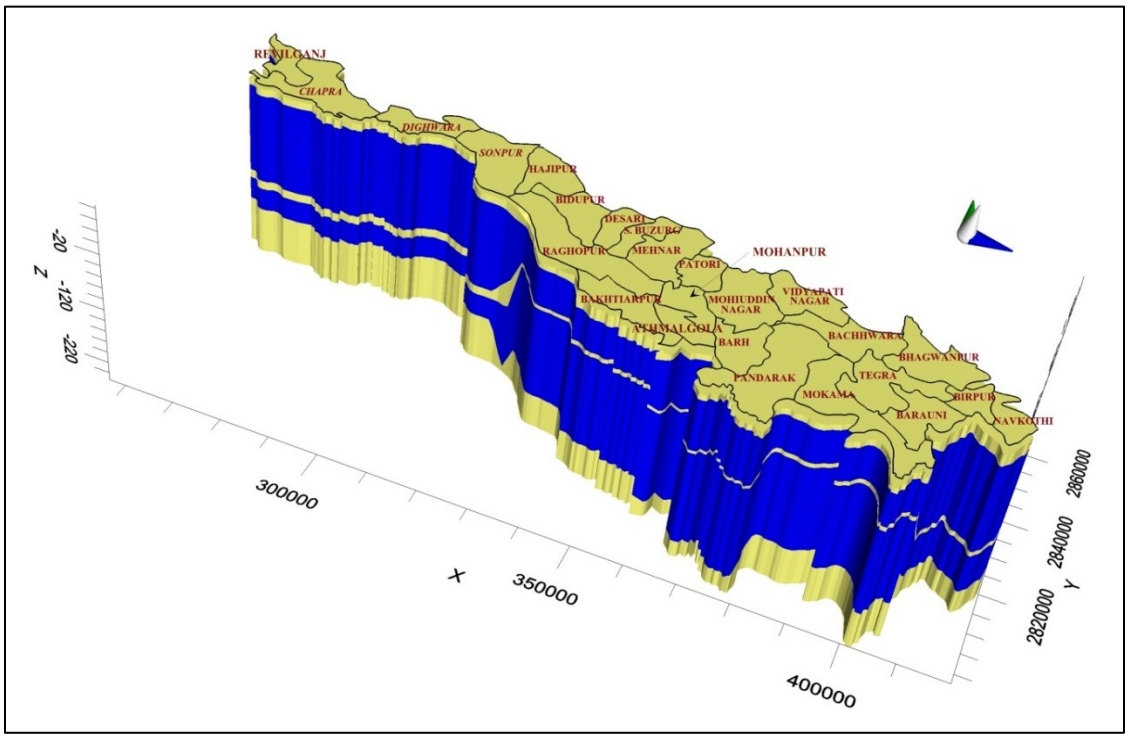
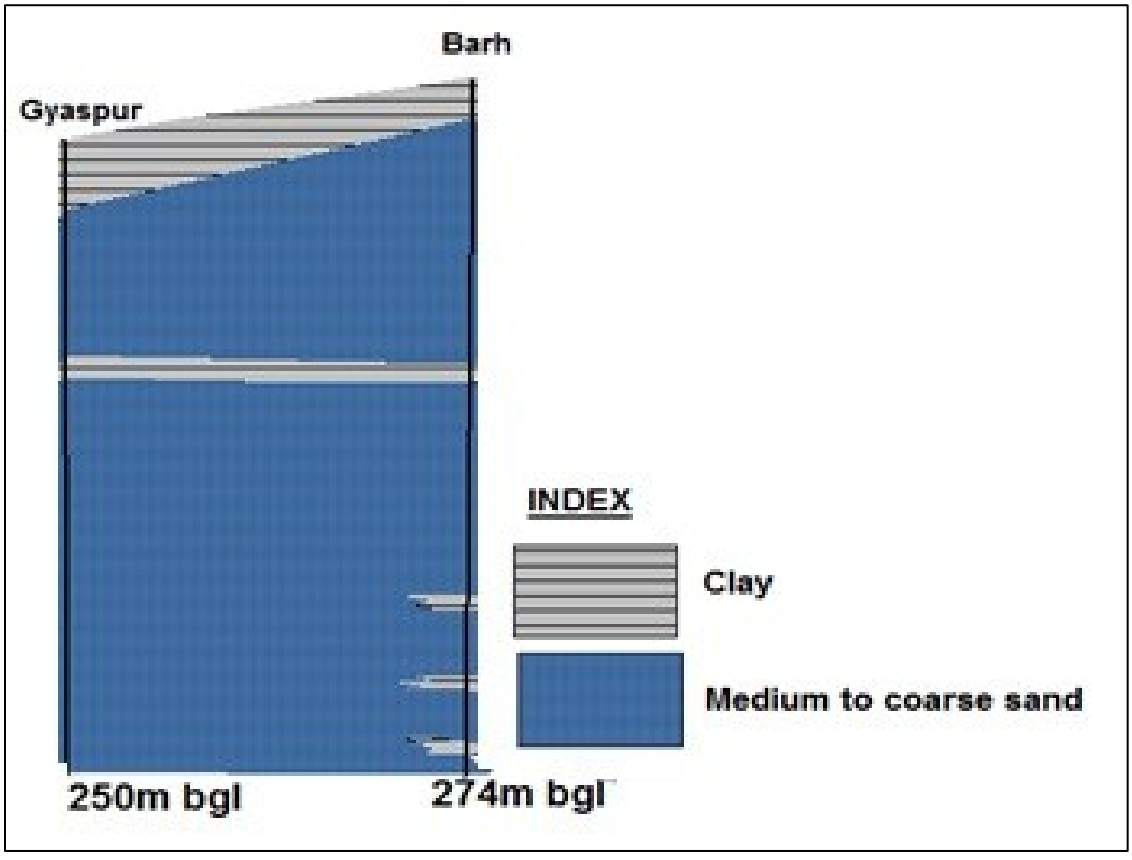


Fig 1: 3D View of aquifer disposition

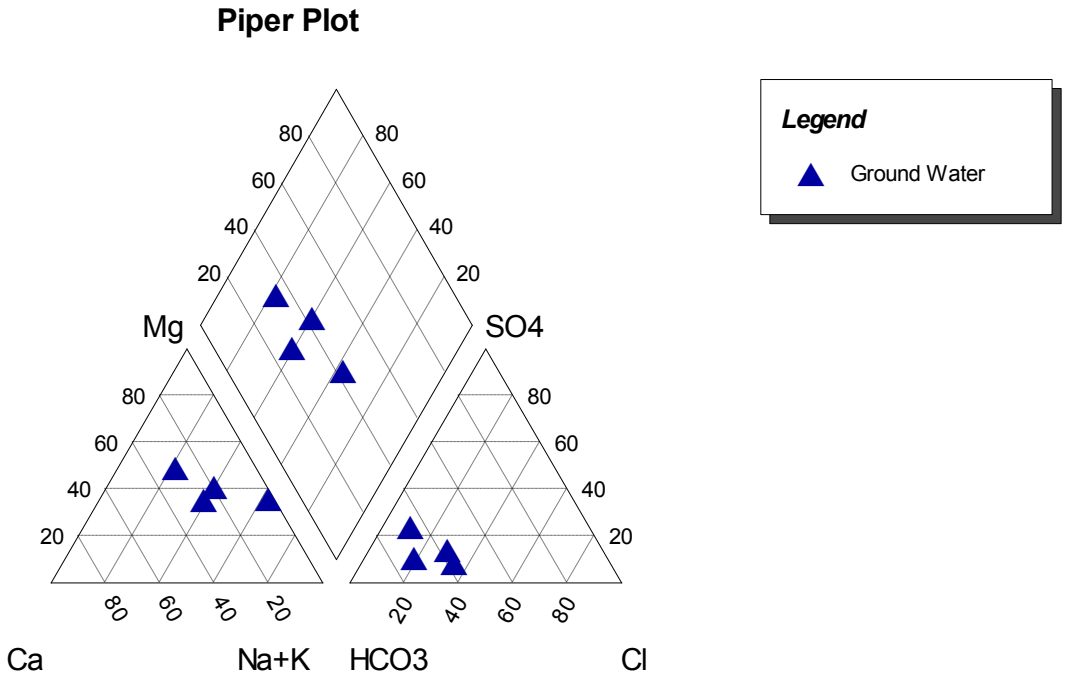


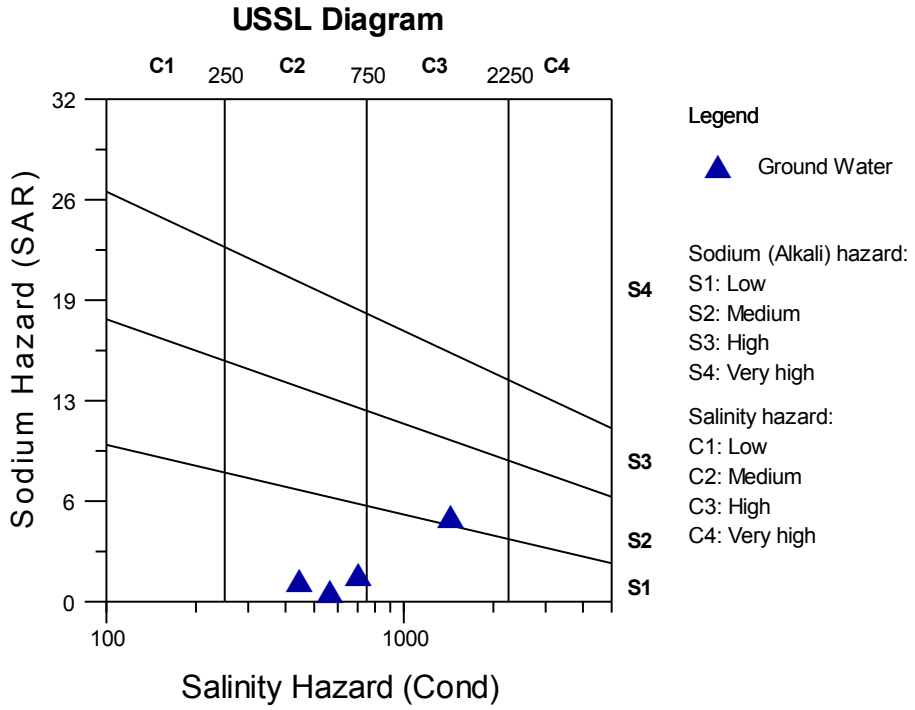
of aquifer disposition Fig 2: 2D View

3. Ground water resource, extraction, contamination and other issues

The overall stage of groundwater development in the Block is 73.9%. Thus sufficient scope exists for groundwater development in the Block. Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energized extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.
The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination





4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aqufer safe from arsenic contamination.

Annexure I

Dynamic Ground Water Resource Estimation

District	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Development (%)	Categc Safe/S critical al/Ove exploit
Patna	Athmalgola	986	242	130	82	1441	144	1296	835	123	958	172	290	73.9	Safe

Annexure II

Chemical Analysis of Ground Water Sample

Sample No.	Location	Long	Lat	Block	District	Source	pH	EC	tds	CO3--	HCO3-	Cl-
19	Ramnagar Diara	85°34′20.4′′	25°28′16.3′′	Athmalgola	Patna	Handpump	7.82	**578**	375.7	0	239.85	24.81
20	Athmalgola	85°36′24.9′′	25°27′35.2′′	Athmalgola (As)	Patna	Handpump	8.20	721	468.65	0	270.60	99.26
21	Surajpura	85°37′33′′	25°26′35′′	Athmalgola	Patna	Dugwell	8.40	1472	956.8	9	528.90	166.61
22	Achuara	85°39′28.4′′	25°27′33.9′′	Athmalgola	Patna	Handpump	8.46	456	296.4	9	196.80	31.90

Block wise
Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km^2)
Bakhtiyarpur

District/ State
PatnaBihar/

Rainfall

The normal annual rainfall of Patna district is 988mm of which %86occurs during the monsoon season. The normal rainfall during monsoon season is 855mm and during non-monsoon season is 133mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice- Wheat, Rice-Gram, Rice- lentil and Rice- Rai. The soils in this zone are sandy loam, clay loam, laom and clay with pH in the range of 6.8-8. The variation of rainfall in this zone is from 990 mm to 1240 mm and the temperature varies from 37.1 to 7.8˚C.

Ground water resource availability and extraction

The dynamic ground water resource of Bakhtiyarpur Block has been assessed as 54.96 MCM. The gross ground water draft for all uses stands at 21.82 MCM. The stage of Development is 39.7%(Annexure I) .

Water level behavior

The depth to water level varies from 6 – 8 m during the pre-monsoon season and from 8 – 10 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below(Fig 1 & 2) .

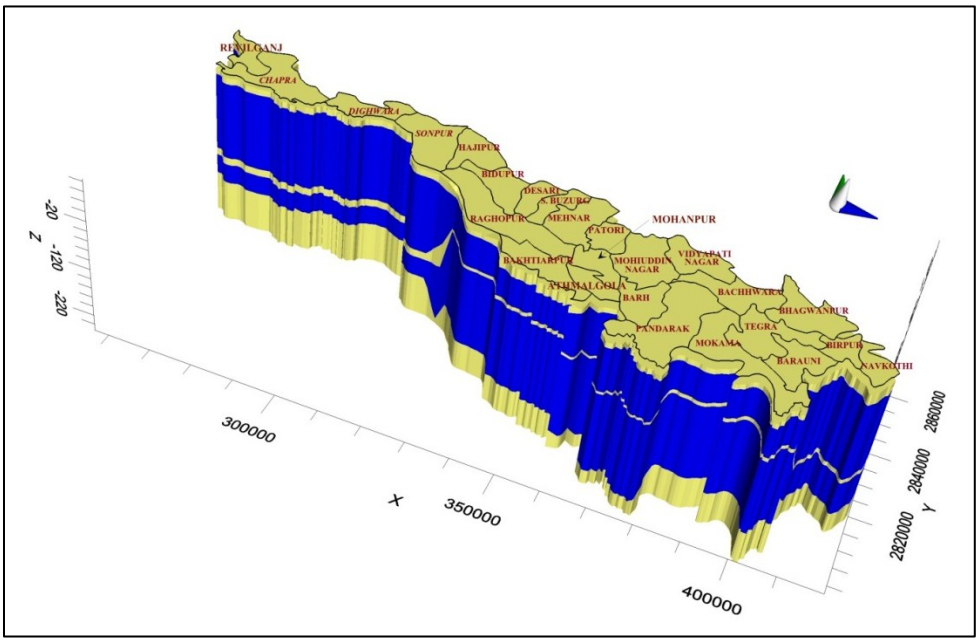


Fig 1: 3D View of aquifer disposition

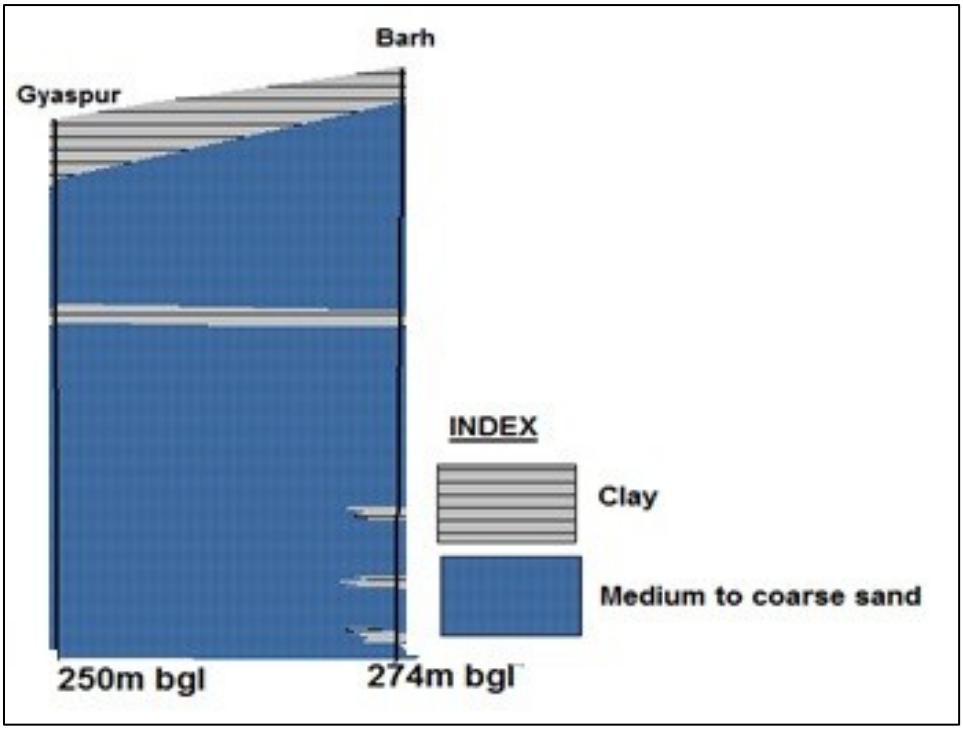


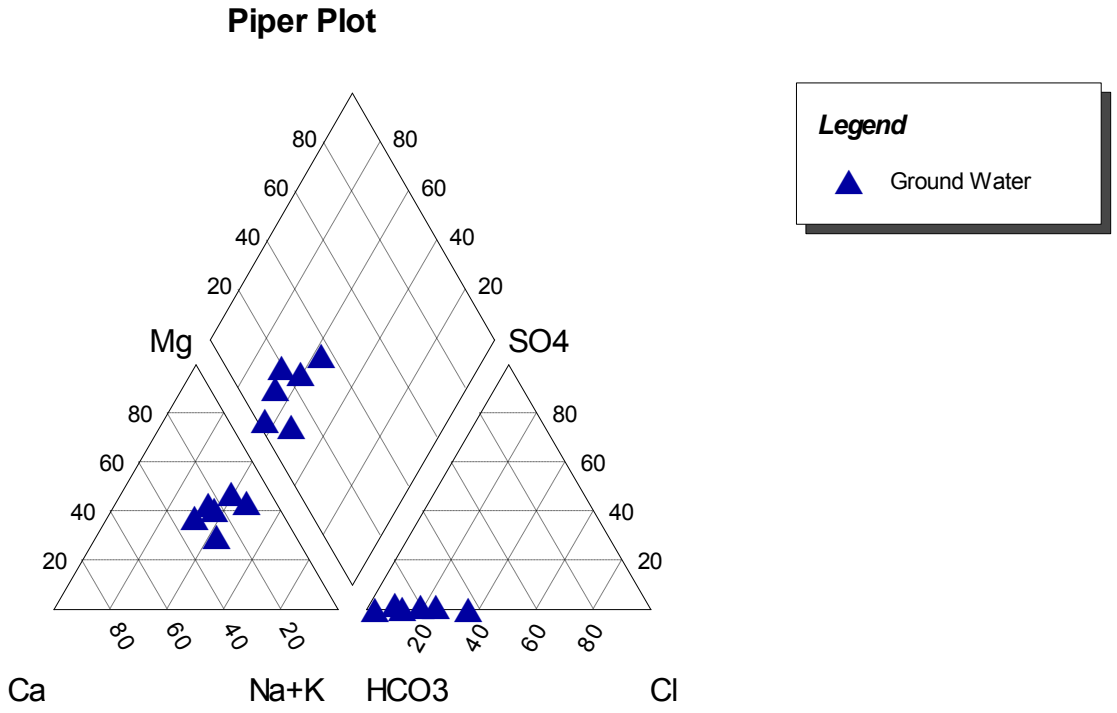
Fig 2: 2D View of aquifer disposition

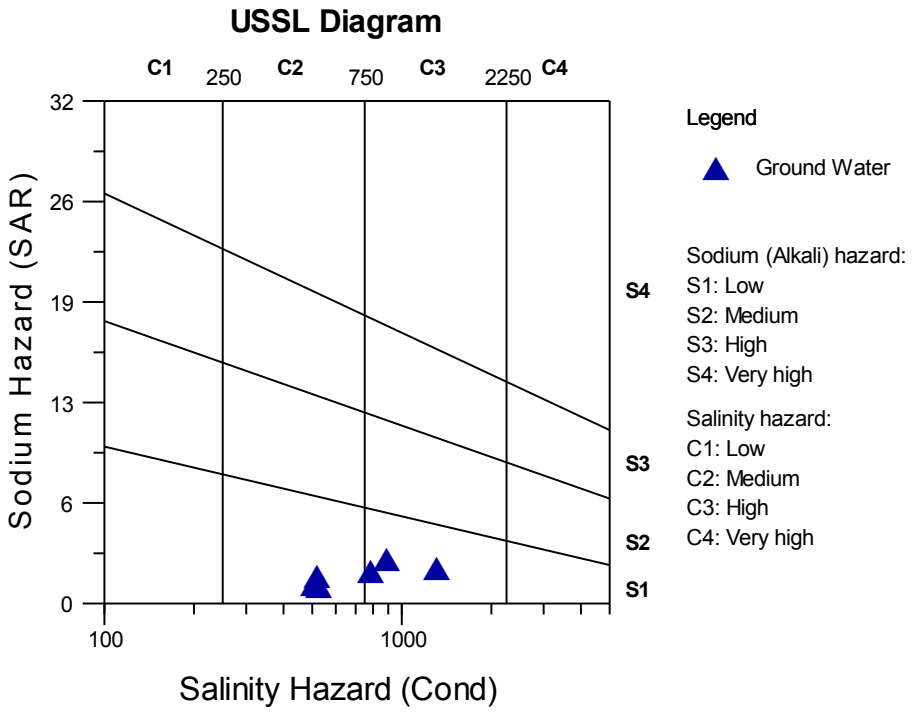
3. Ground water resource, extraction, contamination and other issues

The overall stage of groundwater development in the Block is 39.7%. Thus sufficient scope exists for groundwater development in the Block. Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is

encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.
The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination





4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aqufer safe from arsenic contamination.

Annexure I

Dynamic Ground Water Resource Estimation

District	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Developm ent (%)	Categ Safe/S critica al/Ov explo
Patna	Bakhtiyarpur	4822	483	637	165	6106	611	5496	1700	482	2182	479	3317	39.7	Safe

Annexure II

Chemical Analysis of Ground Water Sample

Sample No.	Location	Long	Lat	Block	District	Source	pH	EC	tds	CO3--	HCO3-	Cl-
68	Rukunpura	85.13737	25.62365	Bakhtiyarpur	Patna	Handpump	8.15	538	344.32	0	244	35.46
69	Bidhipur(Handpump)	85.46111	25.49041	Bakhtiyarpur	Patna	Handpump	8.35	517	330.88	24	231.8	21.276
70	Bidhipur(DG)	85.46111	25.49041	Bakhtiyarpur	Patna	Dugwell	8	1341	858.24	0	677.1	17.3754
71	Alipur	85.44178	25.47373	Bakhtiyarpur	Patna	Handpump	8.31	909	581.76	0	524.6	35.46
72	Hatia	85.49639	25.49042	Bakhtiyarpur	Patna	Handpump	8.22	804	514.56	0	207.4	70.92
73	Gyaspur	85.44611	25.50707	Bakhtiyarpur	Patna	Handpump	8.32	531	339.84	0	250.1	49.644

Block wise
Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km^2)
Barh

District/ State
PatnaBihar/

Rainfall

The normal annual rainfall of Patna district is 988mm of which %86occurs during the monsoon season. The normal rainfall during monsoon season is 855mm and during non-monsoon season is 133mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice- Wheat, Rice-Gram, Rice- lentil and Rice- Rai. The soils in this zone are sandy loam, clay loam, laom and clay with pH in the range of 6.8-8. The variation of rainfall in this zone is from 990 mm to 1240 mm and the temperature varies from 37.1 to 7.8˚C.

Ground water resource availability and extraction

The dynamic ground water resource of Barh Block has been assessed as 31.86 MCM. The gross ground water draft for all uses stands at 16.39 MCM. The stage of Development is 51.4%.(Annexure I)

Water level behavior
The depth to water level varies from 2m to 8 m during the pre-monsoon season and from 4 to 10 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below(Fig 1 & 2) .

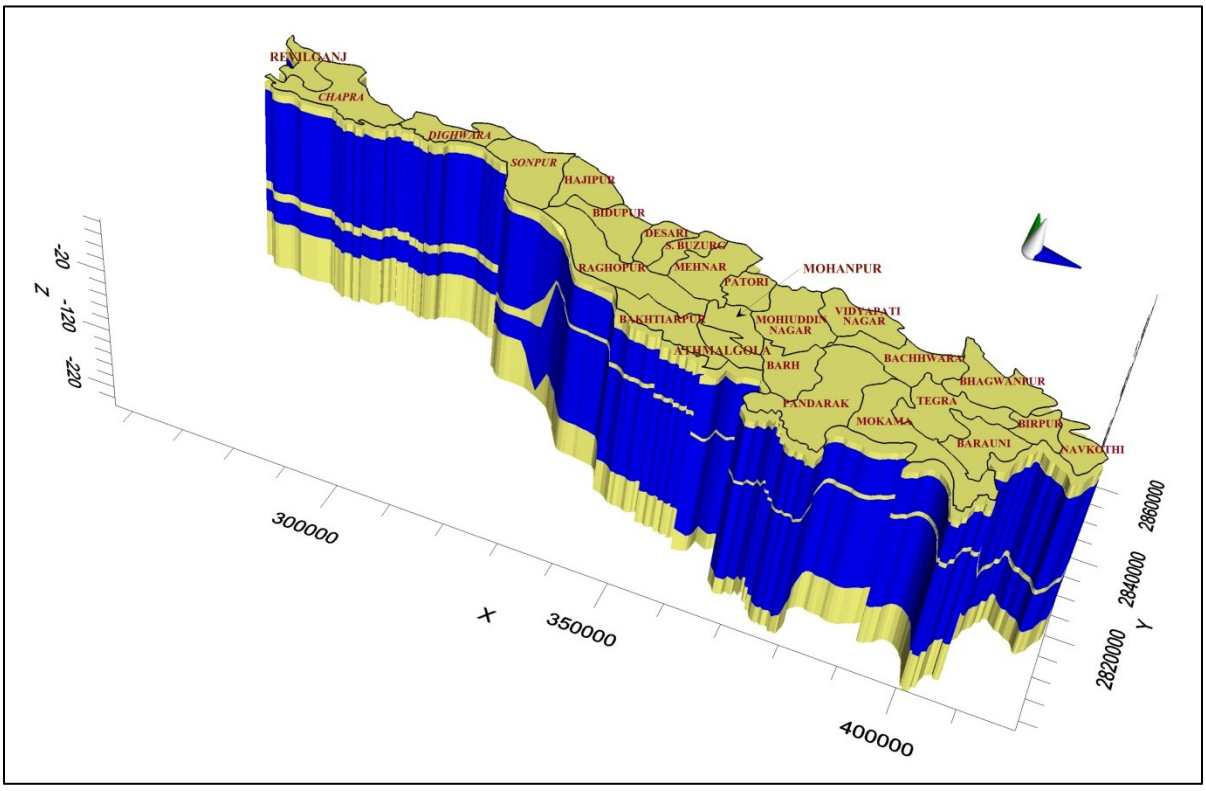


Fig 1: 3D View of aquifer disposition

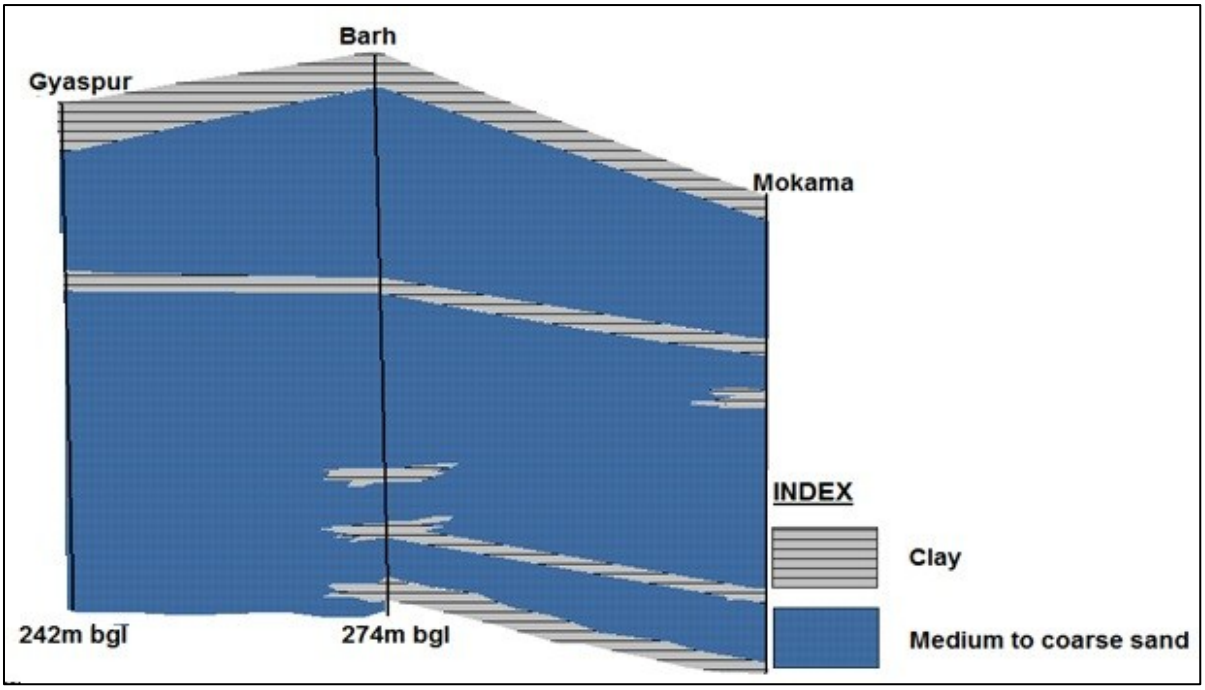


Fig 2: 2D View of aquifer disposition

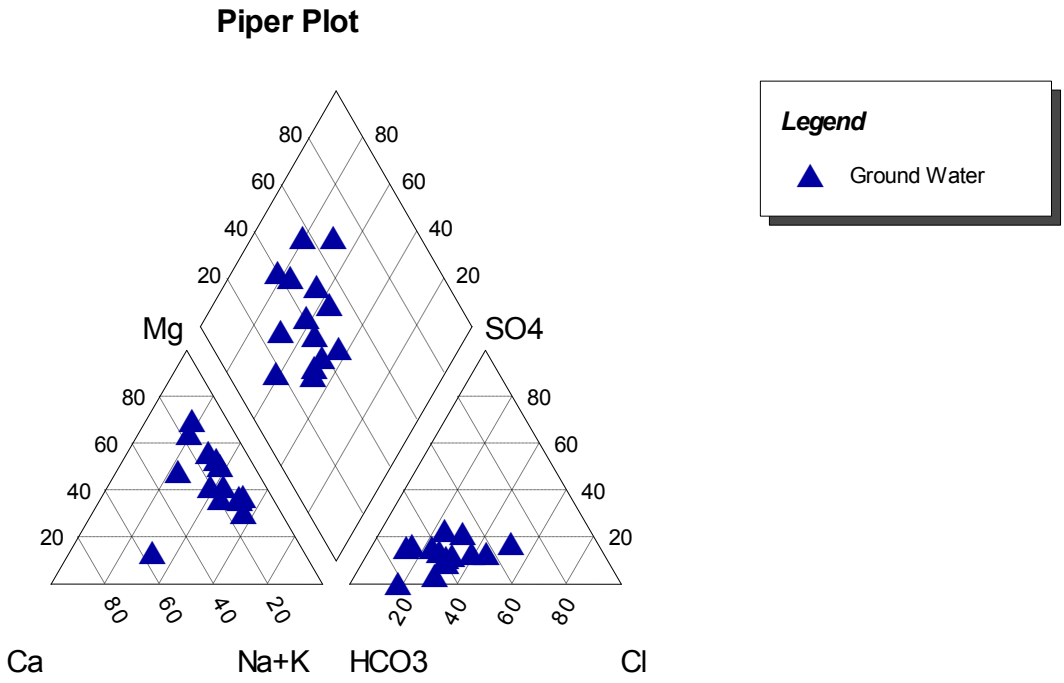
3. Ground water resource, extraction, contamination and other issues

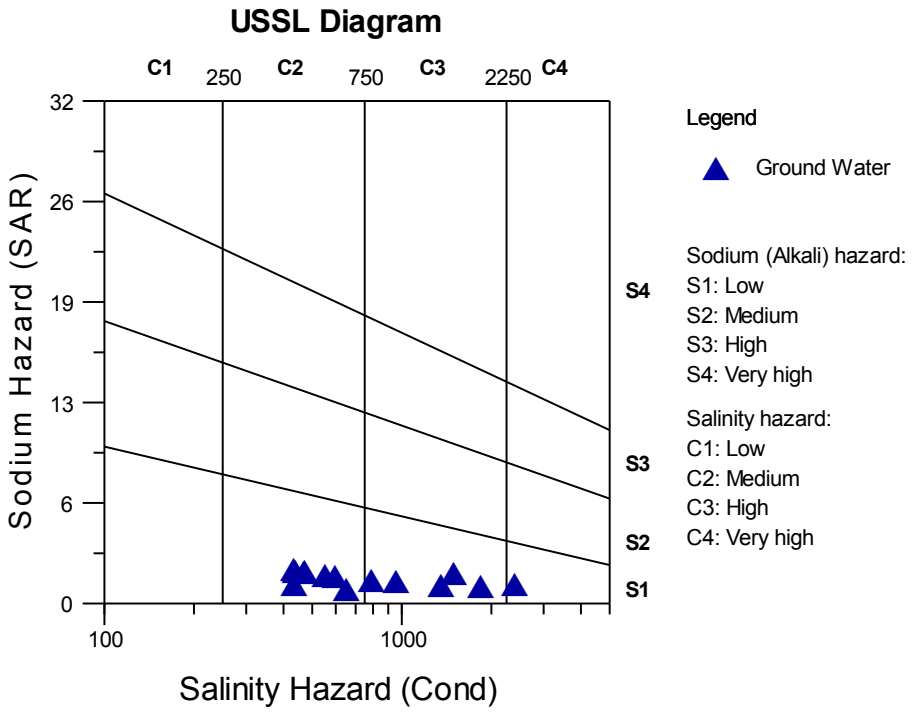
The overall stage of groundwater development in the Block is 51.4%. Thus sufficient scope exists for groundwater development in the Block.

Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.

The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination





4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aqufer safe from arsenic contamination.

Annexure I

Dynamic Ground Water Resource Estimation

Annexure II

District	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Development (%)	Categ Safe/S critica al/Ov explo
Patna	Barh	2685	374	354	127	3540	354	3186	1332	307	1639	479	1375	51.4	Safe

Chemical Analysis of Ground Water Sample

Sample No.	Location	Long	Lat	Block	District	Source	pH	EC	tds	CO3--	HCO3-	Cl-	F
90	Rajpura	85.6426	25.4589	Barh	Patna	Dugwell	7.26	2450	1568	0	817	220	0.16
91	Acchuara	85.6551	25.4599	Barh	Patna	Handpump	8.55	443	283.52	3	116	32	0.25
92	Dahaur	85.6664	25.4617	Barh	Patna	Handpump	7.71	666	426.24	0	177	21	0.3
93	Alaknath (Chondi)	85.6985	25.4701	Barh	Patna	Handpump	8.57	479	306.56	9	195	53	0.04
94	Bajidpur	85.7081	25.4656	Barh	Patna	Dugwell	8.07	1532	980.48	0	384	188	0.73
95	Gulab-bagh	85.7167	25.4789	Barh	Patna	Handpump	8.39	565	361.6	6	201	64	0.3
96	Shahri	85.7284	25.4746	Barh	Patna	Handpump	8.51	808	517.12	9	293	92	0
97	Amarpur (Ranabigha)	85.7360	25.4618	Barh	Patna	Dugwell	7.62	1386	887.04	0	378	131	0.28
98	Agwanpur	85.7317	25.4514	Barh	Patna	Dugwell	7.57	1887	1207.68	0	458	287	1.45
99	Agwanpur	85.7293	25.4524	Barh	Patna	Handpump	8.51	449	287.36	12	171	39	0.05
100	Jamunichak	85.7172	25.4599	Barh	Patna	Handpump	8.46	978	625.92	9	153	152	0.65
101	Kachahri Chowk	85.6924	25.4638	Barh	Patna	Handpump	8.64	610	390.4	12	159	64	0.39
102	Bachiari Malahi	85.6787	25.4618	Barh	Patna	Handpump	8.48	444	284.16	6	207	28	0.26
103	Hasan Chak	85.6488	25.4593	Barh	Patna	Handpump	8.59	482	308.48	12	183	25	0.51

Block wise
Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km^2)
Pandarak

District/ State
PatnaBihar/

Rainfall

The normal annual rainfall of Patna district is 988mm of which %86occurs during the monsoon season. The normal rainfall during monsoon season is 855mm and during non-monsoon season is 133mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice- Wheat, Rice-Gram, Rice- lentil and Rice- Rai. The soils in this zone are sandy loam, clay loam, laom and clay with pH in the range of 6.8-8. The variation of rainfall in this zone is from 990 mm to 1240 mm and the temperature varies from 37.1 to 7.8˚C.

Ground water resource availability and extraction

The dynamic ground water resource of Pandarak Block has been assessed as 59.12 MCM. The gross ground water draft for all uses stands at 25.81 MCM. The stage of Development is 43.7%.

Water level behavior

The depth to water level varies from 4m to 6 m during the pre-monsoon season and from 4 to 10 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below(Fig 1 & 2)

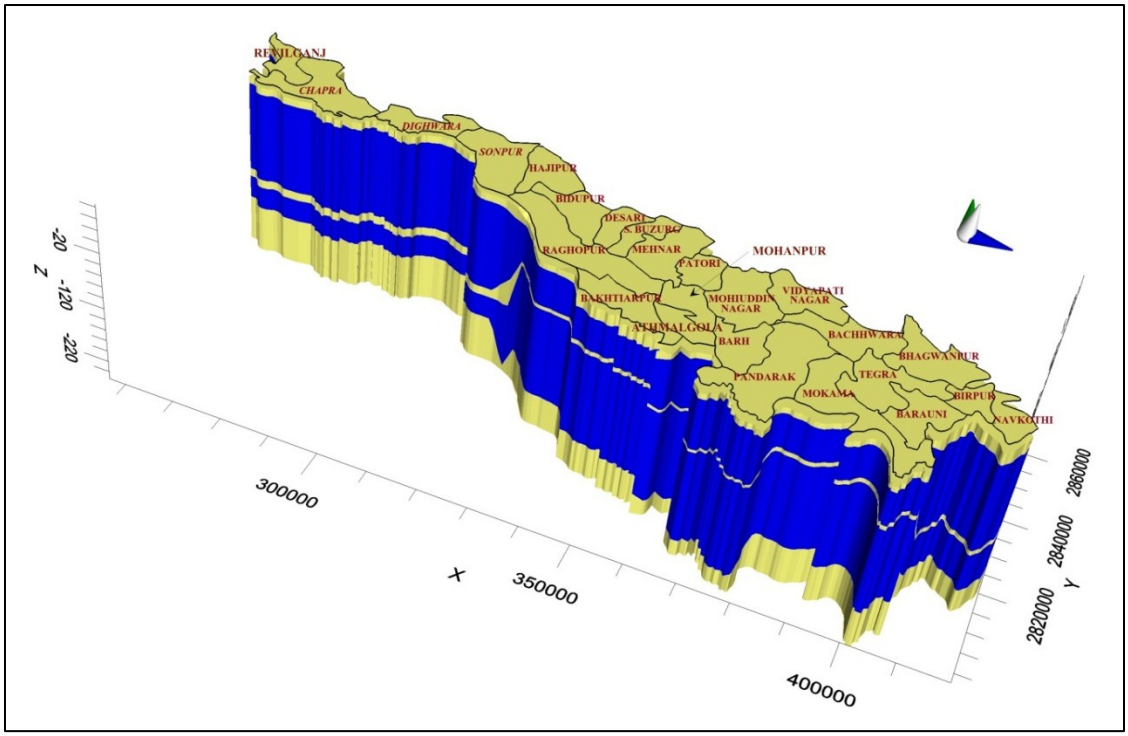


Fig 1: 3D View of aquifer disposition

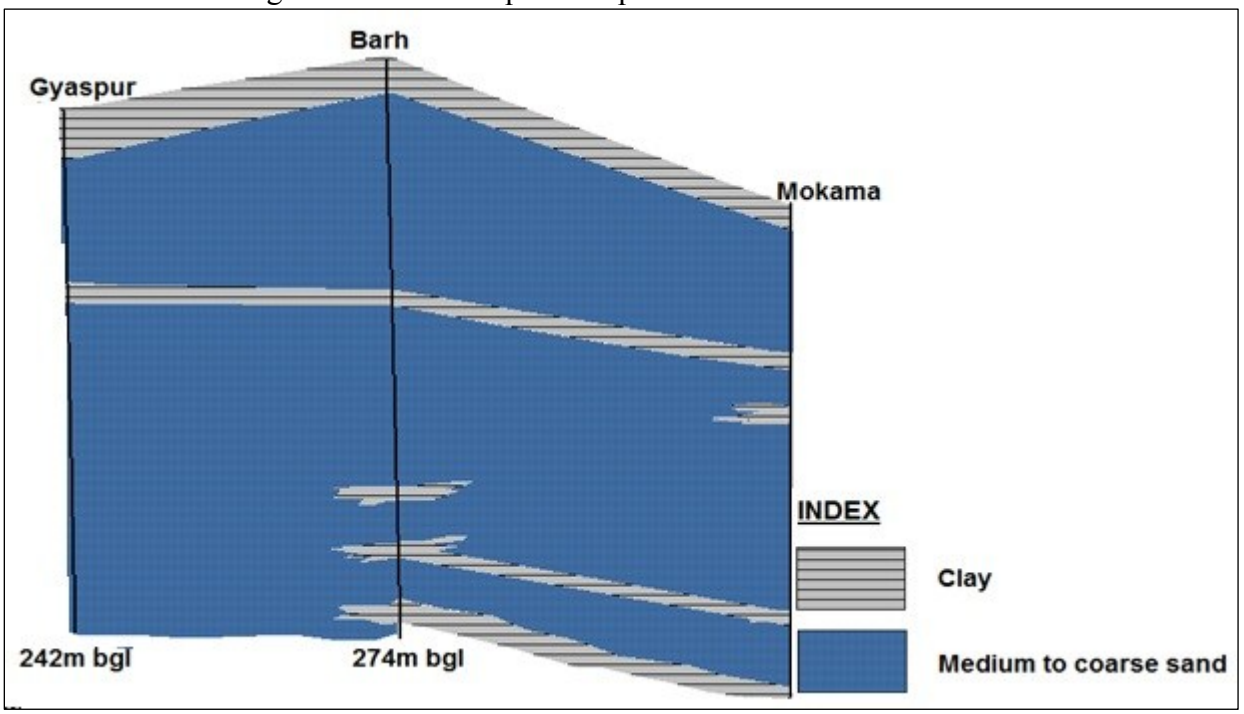


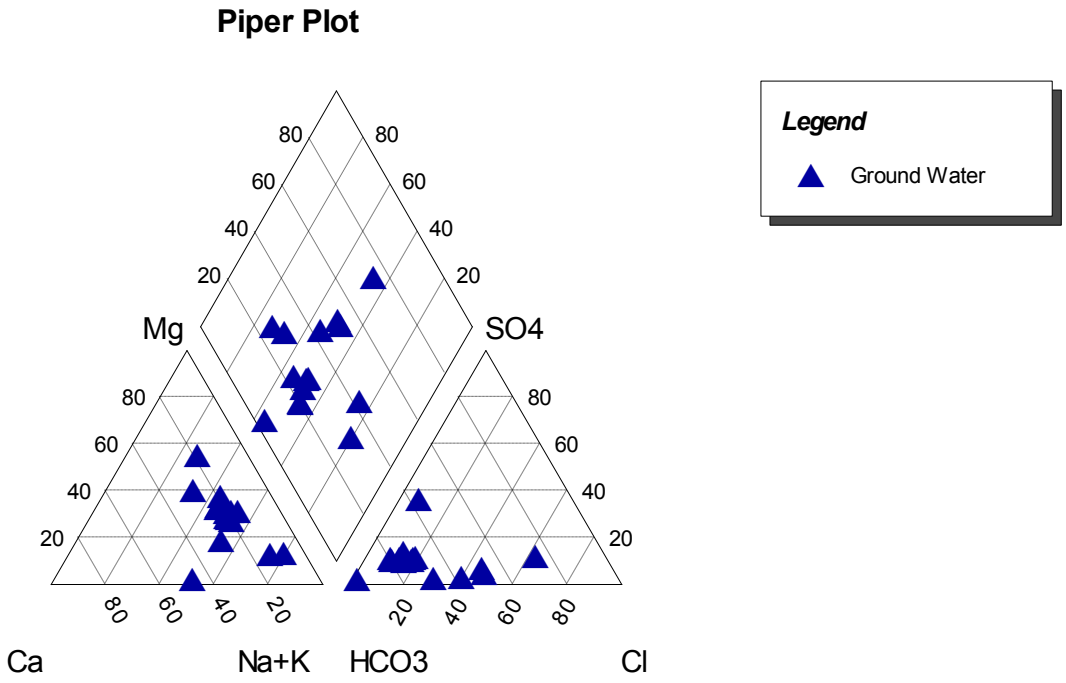
Fig 2: 2D View of aquifer disposition

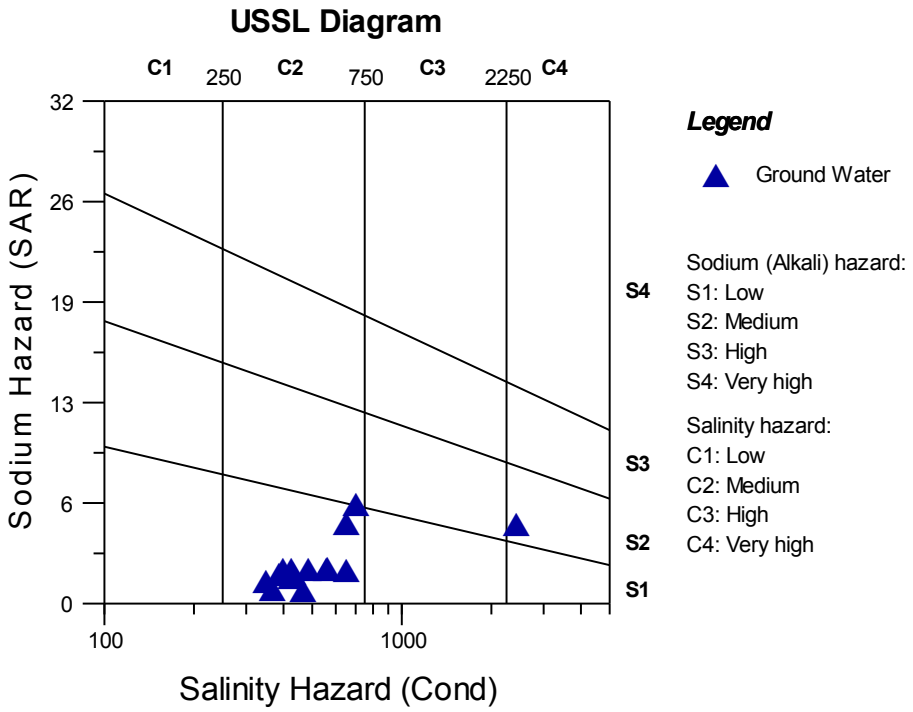
3. Ground water resource, extraction, contamination and other issues

The overall stage of groundwater development in the Block is 43.7%. Thus sufficient scope exists for groundwater development in the Block. Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the

depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.
The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination





4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aqufer safe from arsenic contamination.

Annexure I

Dynamic Ground Water Resource Estimation

District	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Development (%)	Category: Safe/Semi critical/Critical/Over-exploited
Patna	Pandarak	5020	661	663	225	6568	657	5912	2361	220	2581	306	3244	43.7	Safe

Annexure II

Chemical Analysis of Ground Water Sample

Sample No.	Location	Long	Lat	Block	District	Source	pH	EC	tds	CO3--	HCO3-	Cl-
23	Bariarpur	85°45′38.2′′	25°30′3.6′′	Pandarak	Patna	Handpump	8.22	718	466.7	0	319.80	85.0
24	Raili	85°46′13′′	25°29′33.8′′	Pandarak	Patna	Handpump	7.36	666	432.9	0	252.15	106
25	Meghagachi	85°47′42′′	25°29′5.4′′	Pandarak	Patna	Handpump	7.5	574	373.1	0	178.35	106
26	Bampura	85°47′24.5′′	25°28′2.7′′	Pandarak	Patna	Dugwell	7.94	665	432.25	0	184.50	16.
27	G.SeikHandpumpura	85°47′2.6′′	25°27′6.1′′	Pandarak	Patna	Handpump	8.21	395	256.75	0	196.80	24.
28	Manjulabigha	85°46′30.8′′	25°25′57.4′′	Pandarak	Patna	Handpump	7.66	441	286.65	0	209.10	31.
29	Kondi	85°46′5′′	25°25′1′′	Pandarak	Patna	Handpump	8.11	408	265.2	0	209.10	17.
30	Chak Jalal	85°44′39′′	25°23′36′′	Pandarak	Patna	Handpump	8.02	434	282.1	0	233.70	24.
31	Ekdanga	85°42′27′′	25°23′22.7′′	Pandarak	Patna	Handpump	7.44	496	322.4	0	202.95	31.
32	Saksohra	85°42′2.1′′	25°21′49.9′′	Pandarak	Patna	Handpump	8.26	375	243.75	0	172.20	28.
33	Mubarakpur	85°43′59′′	25°20′24′′	Pandarak	Patna	Handpump	8.29	435	282.75	0	227.55	17.
34	Barwane	85°44′55.6′′	25°20′0.1′′	Pandarak	Patna	Dugwell	7..88	2482	1613.3	0	344.40	524
35	Jagmal Chak	85°45′52.4′′	25°19′34.5′′	Pandarak	Patna	Handpump	8.18	476	309.4	0	221.40	24.
36	Pitunjia (As)	85°46′34.8′′	25°20′12.5′′	Pandarak	Patna	Handpump	7.56	357	232.05	0	221.40	3.5
37	Sitarambaghi Kumhartola	85°48′47.7′′	25°20′12.5′′	Pandarak	Patna	Handpump	7.27	570	370.5	0	172.20	99.

Block wise
Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km^2)
Mokamah

District/ State
PatnaBihar/

Rainfall

The normal annual rainfall of Patna district is 988mm of which %86occurs during the monsoon season. The normal rainfall during monsoon season is 855mm and during non-monsoon season is 133mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice- Wheat, Rice-Gram, Rice- lentil and Rice- Rai. The soils in this zone are sandy loam, clay loam, laom and clay with pH in the range of 6.8-8. The variation of rainfall in this zone is from 990 mm to 1240 mm and the temperature varies from 37.1 to 7.8˚C.

Ground water resource availability and extraction

The dynamic ground water resource of Mokamah Block has been assessed as 52.19MCM. The gross ground water draft for all uses stands at 19.25 MCM. The stage of Development is 36.9%.

Water level behavior

The depth to water level varies from 4m to 6 m during the pre-monsoon season and from 2 to 6 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below(Fig 1 & 2)

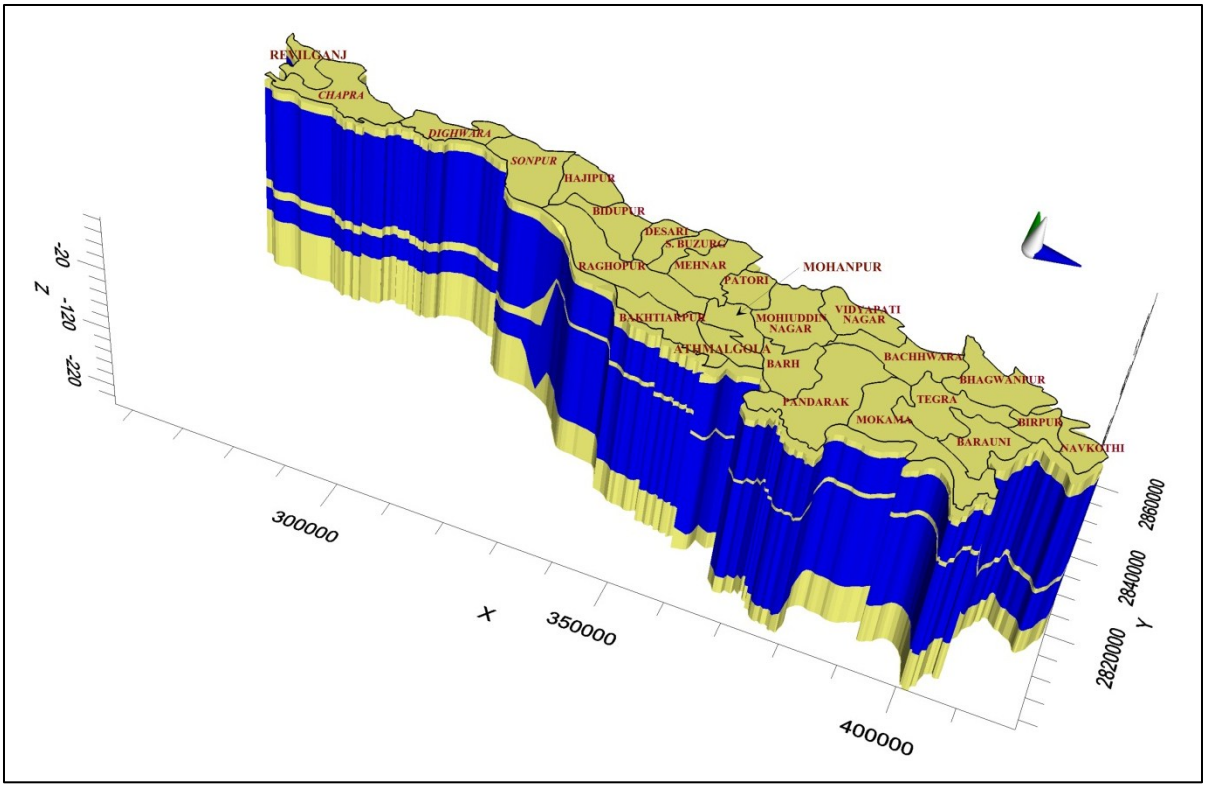


Fig 1:3D View of aquifer disposition

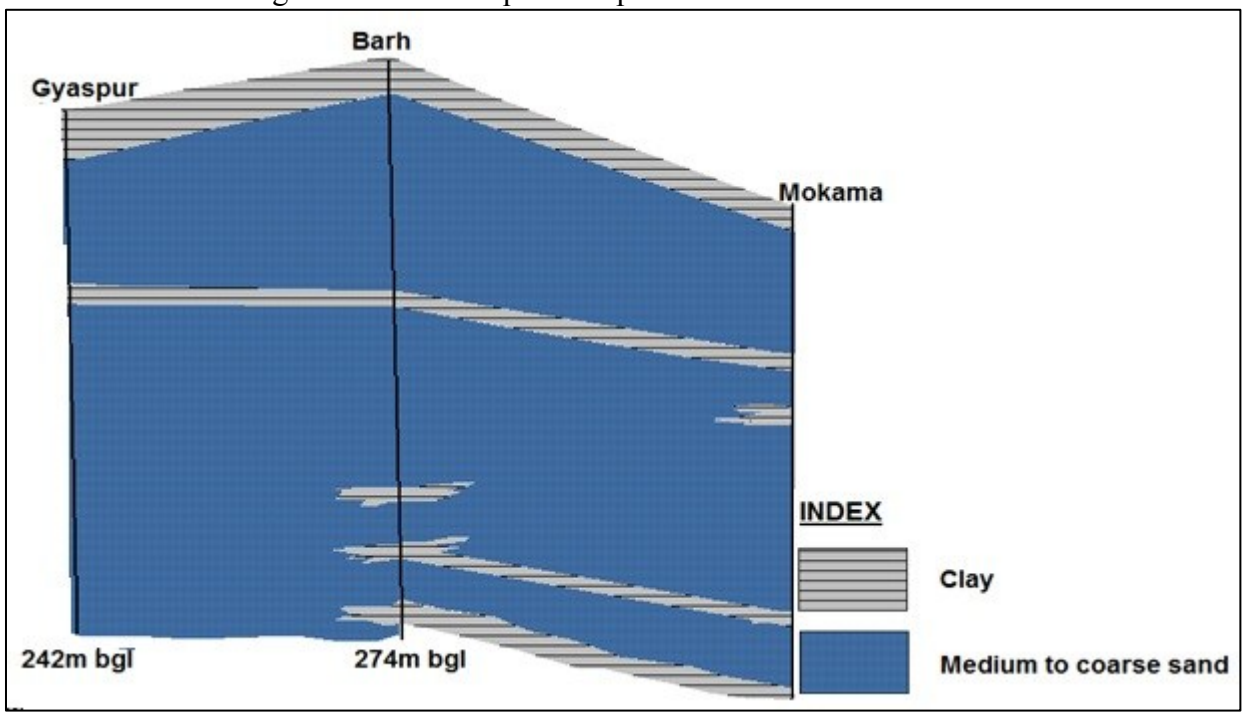


Fig 2: 2D View of aquifer disposition

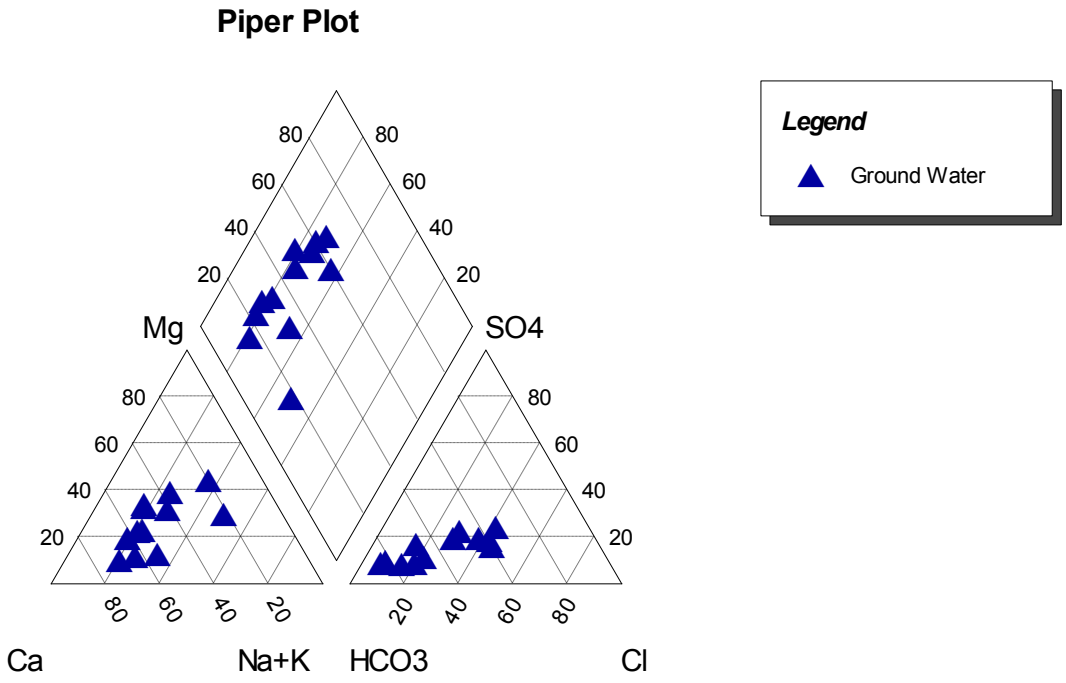
3. Ground water resource, extraction, contamination and other issues

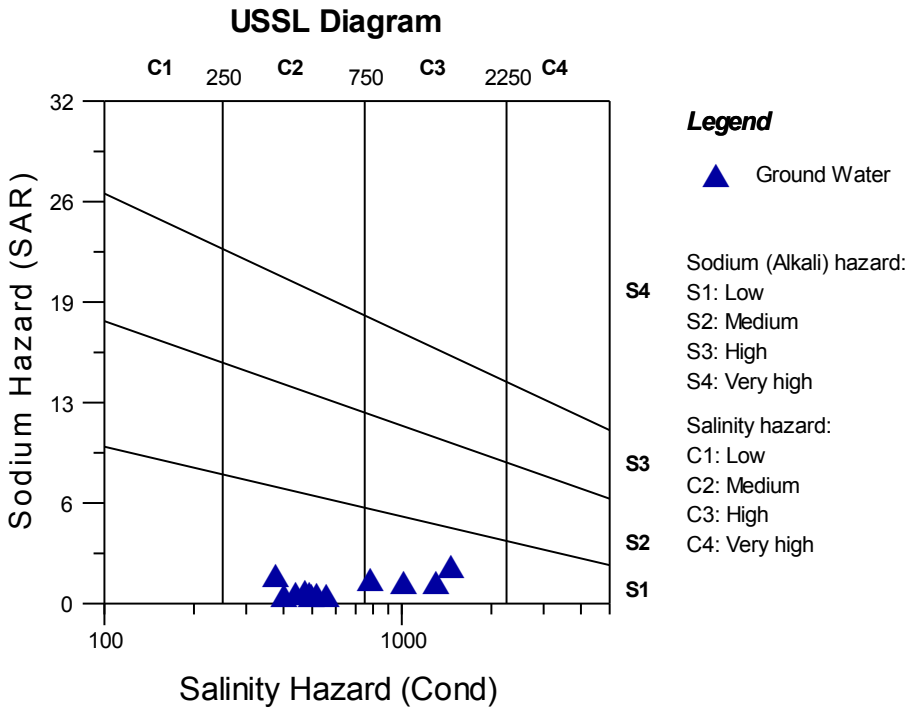
The overall stage of groundwater development in the Block is 36.9%. Thus sufficient scope exists for groundwater development in the Block.

Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.

The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination





4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aqufer safe from arsenic contamination.

Annexure I

Dynamic Ground Water Resource Estimation

District	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Development (%)	Categ Safe/S critica al/Ov explo
Patna	Mokama	4687	368	619	125	5799	580	5219	1319	606	1925	1042	2858	36.9	Safe

Annexure II

Chemical Analysis of Ground Water Sample

Sample No.	Location	Long	Lat	Block	District	Source	pH	EC	tds	CO3--	HCO3-	Cl-
38	Hathidah(AS)	85°59′7.3′′	25°22′12.6′′	Mokama	Patna	Handpump	7.41	385	250.25	0	209.10	14.18
39	Goshain Gaon(As)	85°54′58′′	25°22′53.3′′	Mokama	Patna	Dugwell	8.31	1037	663.68	9	201	152
40	Badpur	85°00′30.7′′	25°19′56.9′′	Mokama	Patna	Dugwell	8.38	1332	852.48	15	256	170
41	Dariarpur tola	85°58′25.8′′	25°22′52.2′′	Mokama	Patna	Handpump	8.61	484	309.76	18	79	43
42	Aunta	85°57′35.2′′	25°23′7.4′′	Mokama	Patna	Handpump	8.13	802	513.28	0	305	46
43	Parshuramsthan	85°54′54.4′′	25°23′57.2′′	Mokama	Patna	Handpump	8.42	508	325.12	6	226	28
44	Seonar	85°53′27′′	25°24′33.3′′	Mokama	Patna	Handpump	8.69	411	263.04	6	159	32
45	Barahapur Bintoli	85°52′40.7′′	25°25′11.8′′	Mokama	Patna	Handpump	8.75	450	288	12	128	43
46	Morh English(As)	85°52′6.6′′	25°25′36.4′′	Mokama	Patna	Handpump	8.57	529	338.56	3	134	50
47	Sultanpur	85°51′24.5′′	25°26′56.9′′	Mokama	Patna	Dugwell	8.29	1496	957.44	0	329	227
48	Kanhaipur	85°50′48.6′′	25°27′46′′	Mokama	Patna	Handpump	8.55	500	320	3	250	14
49	Mekra	85°50′9.3′′	25°28′29.2′′	Mokama	Patna	Handpump	8.39	570	364.8	15	207	35

Block wise
Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km^2)
Bhagawanpur

District/ State
BegusaraiBihar/

Rainfall

The normal annual rainfall of Begusarai district is 1102mm of which %80occurs during the monsoon season. The normal rainfall during monsoon season is 889mm and during non-monsoon season is 213mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone I. The cropping sequence followed in Agro-climatic Zone I is Rice- Wheat, Rice- Rai, Rice-Sweet Potato, Rice-Maize, Maize-Wheat, Maize-Sweet Potato, Maize-Rai, Rice-lentil and Rice-linseed. The soils in this zone are sandy loam and loam with pH in the range of 6.5-8.4 The variation of rainfall in this zone is from 1040-1450 mm and the temperature varies from 36.6 to 7.7˚C.

Ground water resource availability and extraction

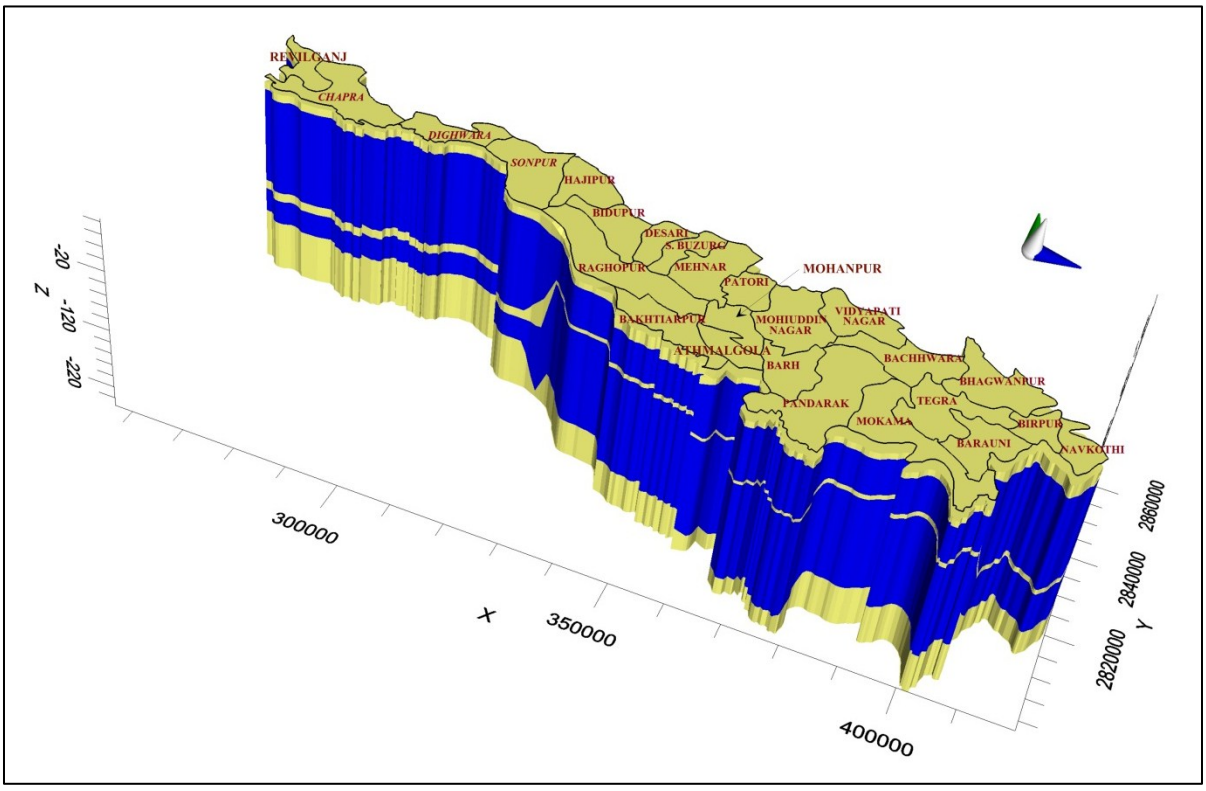
The dynamic ground water resource of Bhagawanpur Block has been assessed as 35.48 MCM. The gross ground water draft for all uses stands at 21.23 MCM. The stage of Development is 59.8%(I -Annexure) .

Water level behavior

The depth to water level varies from 4m to 6 m during the pre-monsoon season and from 2 to 6 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below(Fig 1 & 2) .



aquifer disposition Fig 1:3D View of

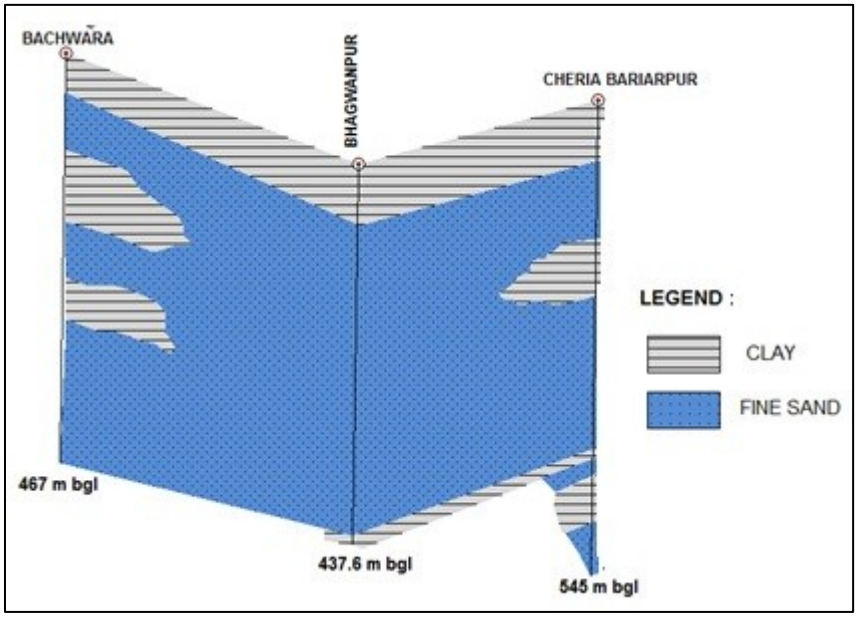


Fig 2: 2D View of aquifer disposition

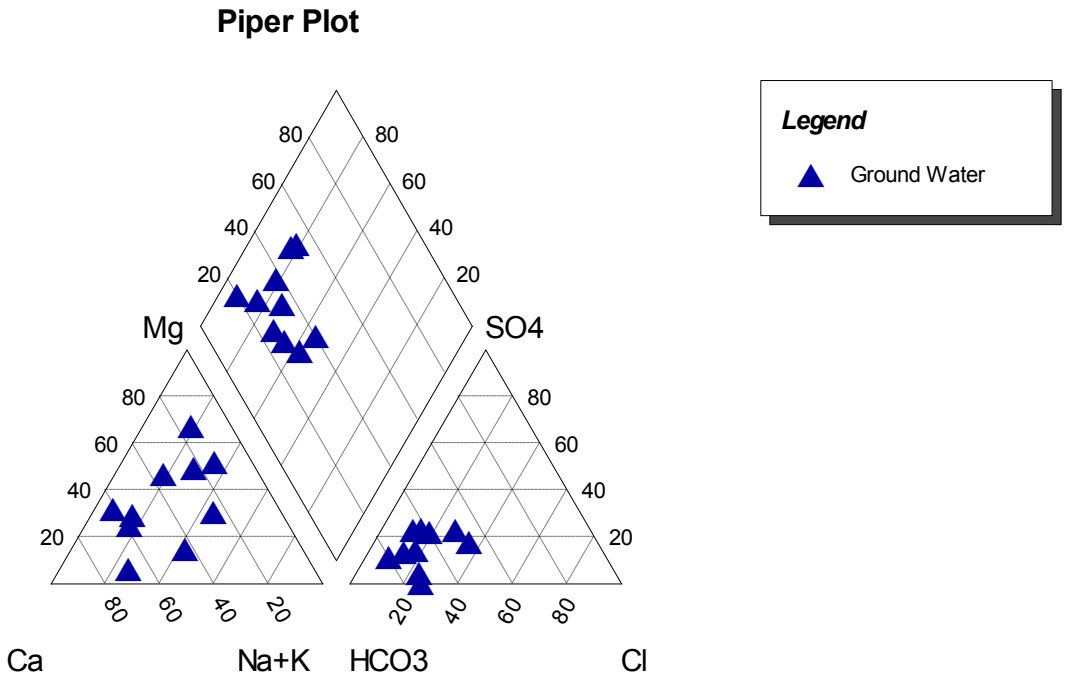
3. Ground water resource, extraction, contamination and other issues

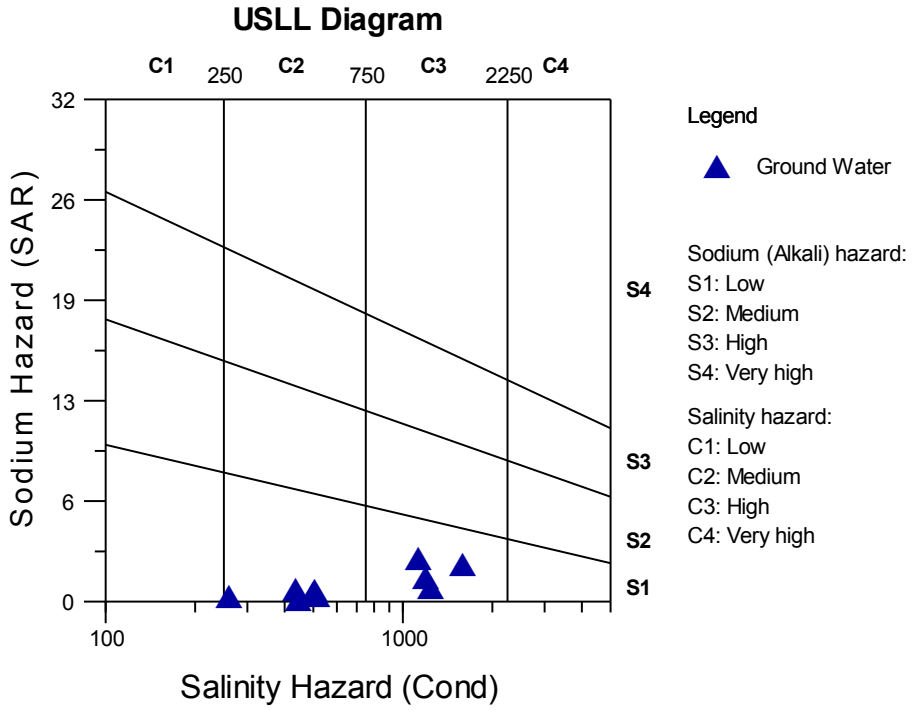
The overall stage of groundwater development in the Block is 59.8%. Thus sufficient scope exists for groundwater development in the Block.

Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.

The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination





4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aqufer safe from arsenic contamination.

Annexure I

Dynamic Ground Water Resource Estimation

Annexure II

District	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Development (%)	Categ Safe/S critica ical/O exploi
Begusarai	Bhagwanpur	2952	195	432	363	3942	394	3548	1859	265	2123	453	1237	59.8	safe

Chemical Analysis of Ground Water Sample

Sample No.	Location	Long	Lat	Block	District	Source	pH	EC	tds	CO3--	HCO3-	Cl
50	Dahia	85°00′50.6′′	25°32′18.1′′	Bhagwanpur	Begusarai	Handpump	8.97	266	170.24	18	61	
51	Bhardiha	85°59′16.3′′	25°32′57.2′′	Bhagwanpur	Begusarai	Handpump	8.6	526	336.64	24	183	
52	Garhuni	85°57′35.4′′	25°34′0.5′′	Bhagwanpur	Begusarai	Handpump	8.9	446	285.44	27	134	
53	Manupur	85°57′35.4′′	25°35′33.3′′	Bhagwanpur	Begusarai	Handpump	8.85	510	326.4	30	140	
54	Dohta	85°59′22.8′′	25°35′22.3′′	Bhagwanpur	Begusarai	Handpump	8.1	1221	781.44	0	537	
55	JagdisHandpumpur	86°00′40.6′′	25°34′45.8′′	Bhagwanpur	Begusarai	Handpump	8.06	1270	812.8	0	354	
56	Sanjat (As)	86°01′3.4′′	25°35′49.1′′	Bhagwanpur	Begusarai	Handpump	8.54	455	291.2	9	195	
57	Tajpur	86°01′1′′	25°34′17.1′′	Bhagwanpur	Begusarai	Dugwell	8.4	1154	738.56	12	384	
58	Narharpur(As)	86°02′21′′	25°34′23.1′′	Bhagwanpur	Begusarai	Handpump	8.7	517	330.88	33	153	
59	Naula	86°03′55.5′′	25°33′29.1′′	Bhagwanpur	Begusarai	Handpump	8.33	1625	1040	18	677	

Block wise
Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km^2)
Birpur

District/ State
BegusaraiBihar/

Rainfall

The normal annual rainfall of Begusarai district is 1102mm of which %80occurs during the monsoon season. The normal rainfall during monsoon season is 889mm and during non-monsoon season is 213mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone I. The cropping sequence followed in Agro-climatic Zone I is Rice- Wheat, Rice- Rai, Rice-Sweet Potato, Rice-Maize, Maize-Wheat, Maize-Sweet Potato, Maize-Rai, Rice-lentil and Rice-linseed. The soils in this zone are sandy loam and loam with pH in the range of 6.5-8.4 The variation of rainfall in this zone is from 1040-1450 mm and the temperature varies from 36.6 to 7.7˚C.

Ground water resource availability and extraction

The dynamic ground water resource of Birpur Block has been assessed as 17.92 MCM. The gross ground water draft for all uses stands at 16.56 MCM. The stage of Development is 92.4%(Annexure I) .

Water level behavior

The depth to water level varies from 4m to 6 m during the pre-monsoon season and from 2 to 6 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below.

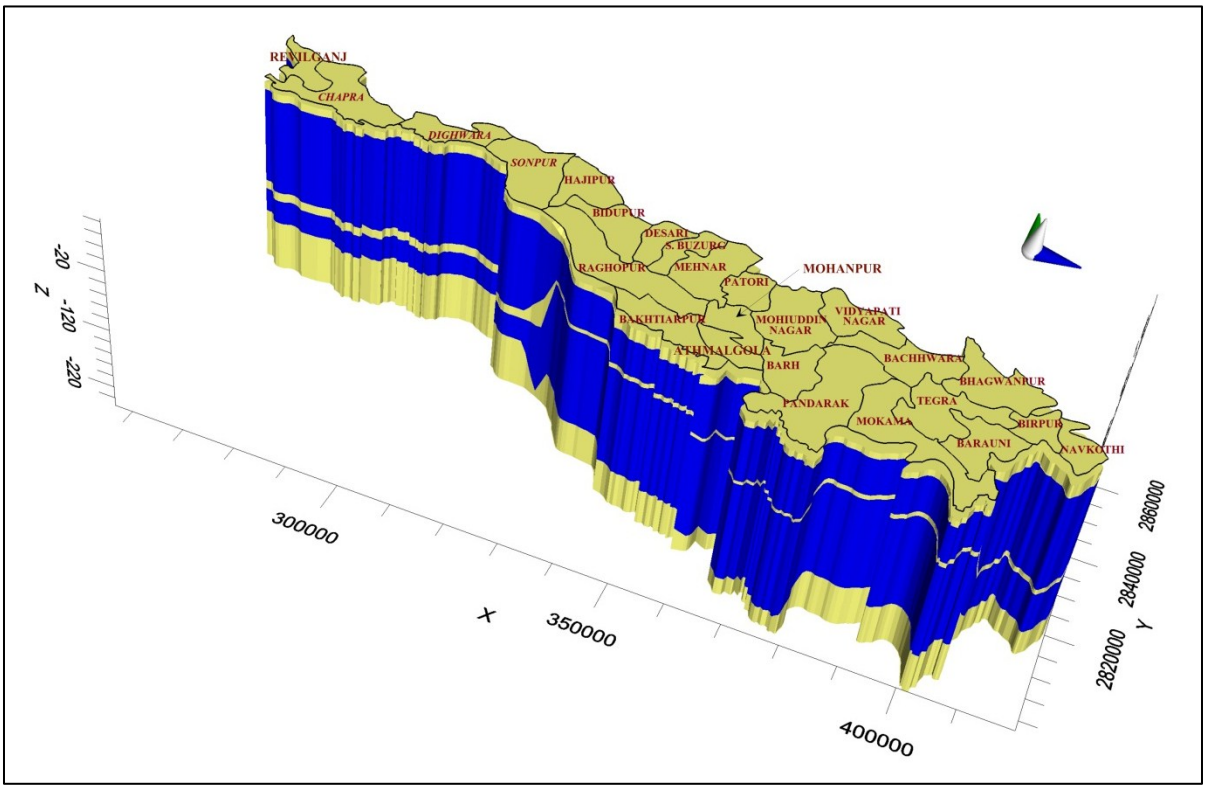


Fig 1:3D View of aquifer disposition

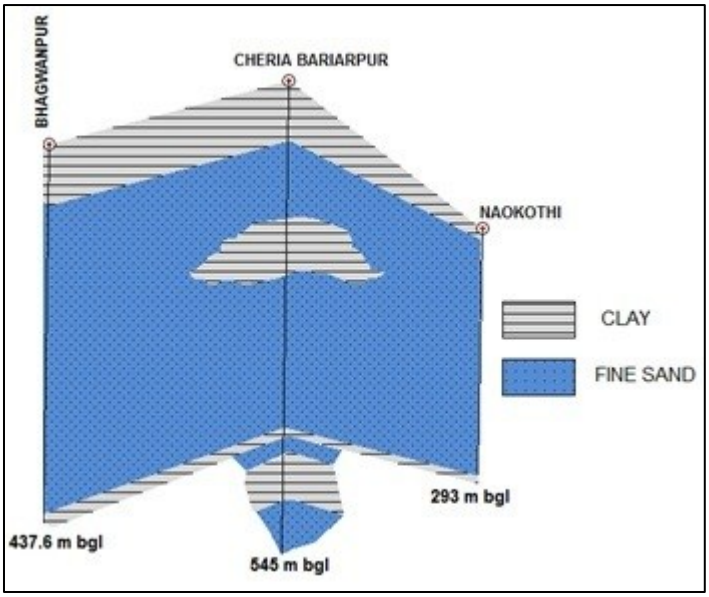


Fig 2: 2D View of aquifer disposition

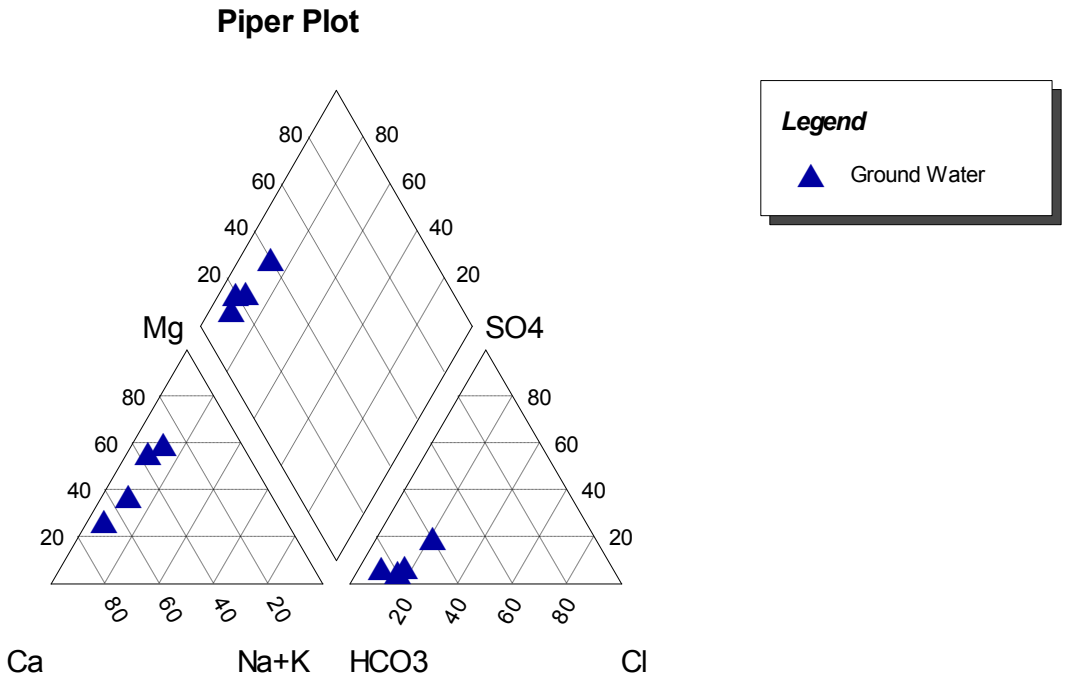
3. Ground water resource, extraction, contamination and other issues

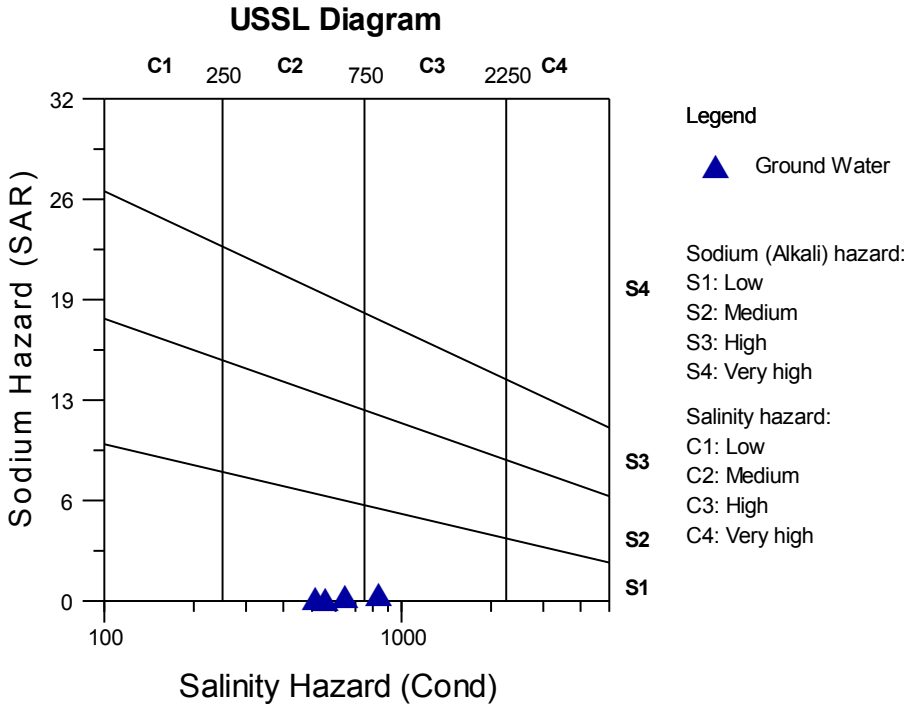
The overall stage of groundwater development in the Block is 92.4%. Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is

safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.

The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination





4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aqufer safe from arsenic contamination.

Annexure I

Dynamic Ground Water Resource Estimation

District	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Development (%)	Category: Safe/Semi-critical/Critical/Over-exploited
Begusarai	Birpur	1344	157	197	293	1991	199	1792	1506	150	1656	258	29	92.4	Semi-Critical

Annexure II

Chemical Analysis of Ground Water Sample

Sample No.	Location	Long	Lat	Block	District	Source	pH	EC	tds	CO3--	HCO3-	Cl-	F
60	Pakdi	86°05′35.5′′	25°32′1.5′′	Birpur	Begusarai	Handpump	8.72	857	548.48	15	293	64	0.7
61	Parra(As)	86°05′57.8′′	25°29′42.6′′	Birpur	Begusarai	Handpump	8.5	660	422.4	27	232	32	0.9
62	Phulkari	86°06′17.2′′	25°29′9.5′′	Birpur	Begusarai	Handpump	8.65	524	335.36	27	214	14	1.2
63	Kajichak	86°07′2.8′′	25°28′8.2′′	Birpur	Begusarai	Handpump	8.5	567	362.88	21	232	28	0.6

Block wise
Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km^2)
Bidupur

District/ State
VaishaliBihar/

Rainfall

The normal annual rainfall of Vaishali district is 1089mm of which %84occurs during the monsoon season. The normal rainfall during monsoon season is 922mm and during non-monsoon season is 167mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone I. The cropping sequence followed in Agro-climatic Zone I is Rice- Wheat, Rice- Rai, Rice-Sweet Potato, Rice-Maize, Maize-Wheat, Maize-Sweet Potato, Maize-Rai, Rice-lentil and Rice-linseed. The soils in this zone are sandy loam and loam with pH in the range of 6.5-8.4 The variation of rainfall in this zone is from 1040-1450 mm and the temperature varies from 36.6 to 7.7˚C.

Ground water resource availability and extraction

The dynamic ground water resource of Bidupur Block has been assessed as 75.93 MCM. The gross ground water draft for all uses stands at 27.51 MCM. The stage of Development is 36.2%.

Water level behavior

The depth to water level varies from 4m to 8m during the pre-monsoon season and from 2 to 6 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below (Fig 1&2).

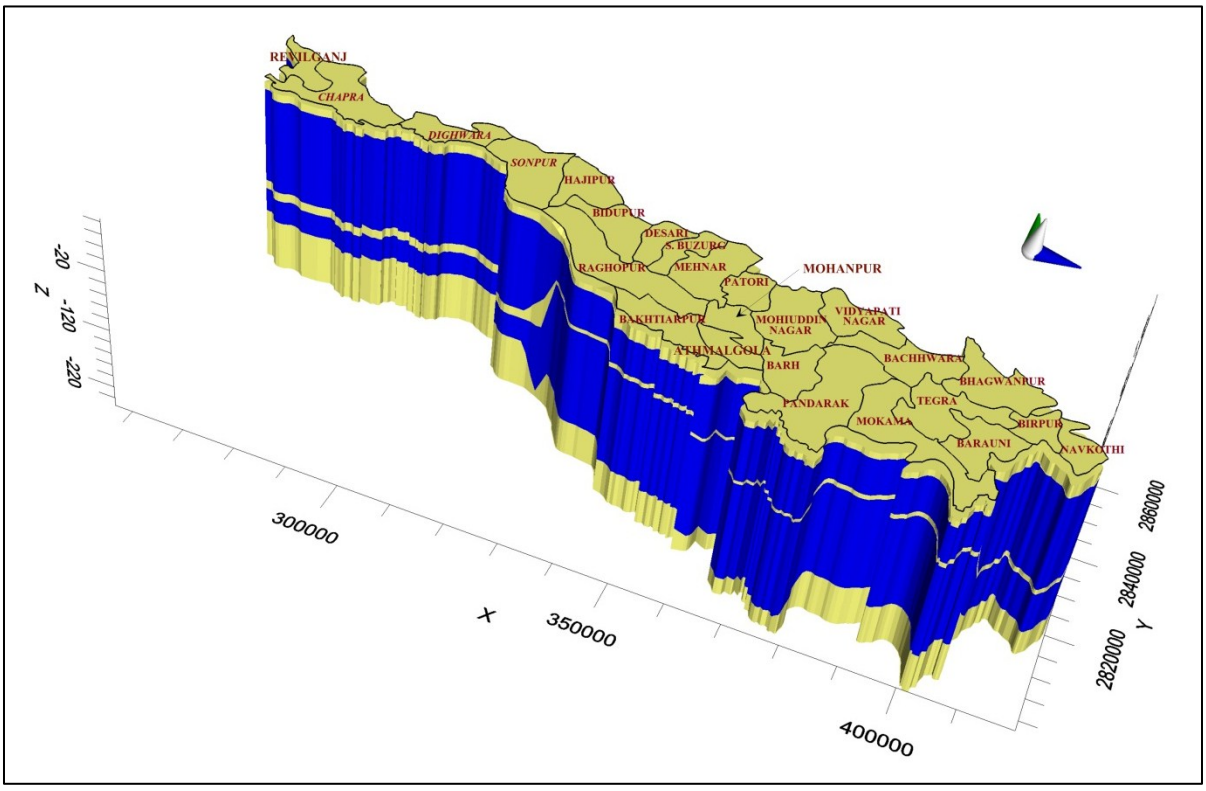
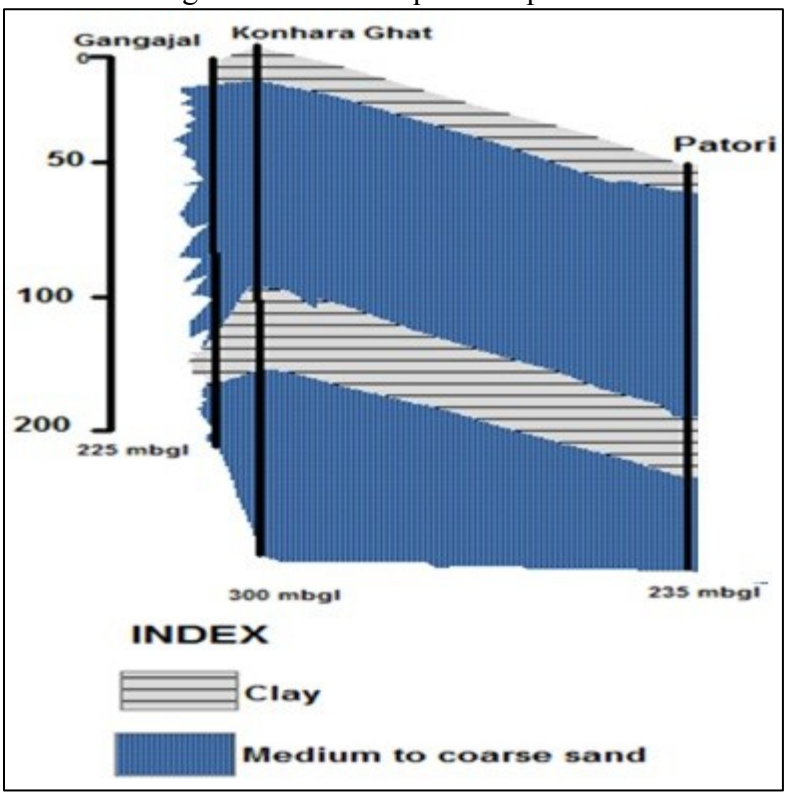


Fig 1:3D View of aquifer disposition

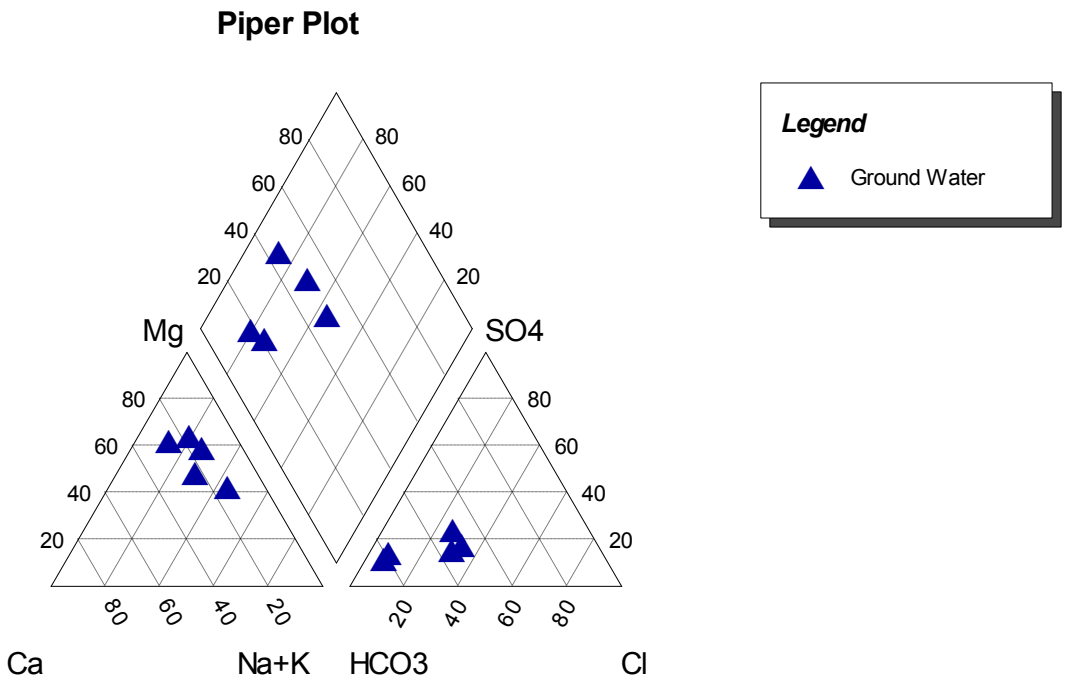


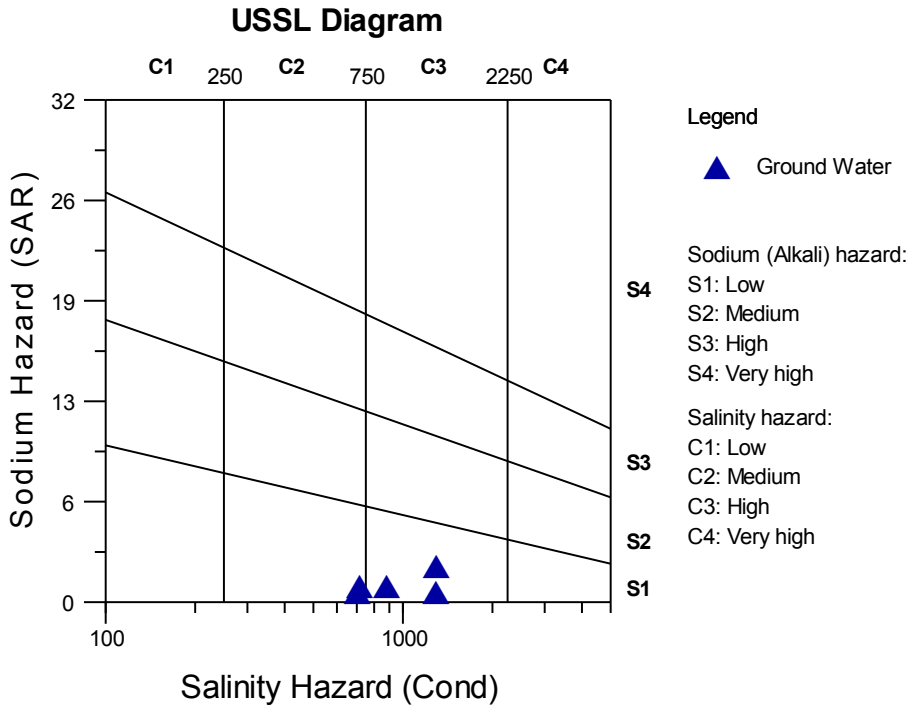
disposition Fig 2: 2D View of aquifer

3. Ground water resource, extraction, contamination and other issues

The overall stage of groundwater development in the Block is 36.2%. Thus sufficient scope exists for groundwater development in the Block. Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.
The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination





4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aqufer safe from arsenic contamination.

Annexure I

Dynamic Ground Water Resource Estimation

District	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Development (%)	Categc Safe/Sc critical al/Ove exploit
Vaishali	Bidupur	2530	1864	421	3178	7992	400	7593	2369	382	2751	562	4662	36.2	Safe

Annexure II

Chemical Analysis of Ground Water Sample

Sample No.	Location	Long	Lat	Block	District	Source	pH	EC	tds	CO3--	HCO3-	Cl
16	Maniyarpur	85.3938	25.62242	Biddupur	Vaishali	Handpump	7.22	719	460.16	0	317	
17	Near Kutubpur Chauk	85.3704	25.62606	Biddupur	Vaishali	Handpump	7.1	1321	845.44	0	409	
18	Opposite Biddupur Police Station	85.3329	25.64328	Biddupur	Vaishali	Handpump	7.96	732	468.48	0	336	
88	Khalsa chowk	85.37797	25.64038	Bidupur	Vaishali	Handpump	8.26	1328	849.92	0	341.6	10
89	Pakauli	85.28438	25.67369	Bidupur	Vaishali	Handpump	8.13	902	577.28	0	237.9	9

Block wise
Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km^2)
Hajipur

District/ State
VaishaliBihar/

Rainfall

The normal annual rainfall of Vaishali district is 1089mm of which %84occurs during the monsoon season. The normal rainfall during monsoon season is 922mm and during non-monsoon season is 167mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice- Wheat, Rice-Gram, Rice- lentil and Rice- Rai. The soils in this zone are sandy loam, clay loam, laom and clay with pH in the range of 6.8-8. The variation of rainfall in this zone is from 990 mm to 1240 mm and the temperature varies from 37.1 to 7.8˚C.

Ground water resource availability and extraction

The dynamic ground water resource of Hajipur Block has been assessed as 33.89 MCM. The gross ground water draft for all uses stands at 24.71MCM. The stage of Development is 72.9%(Annexure I) .

Water level behavior

The depth to water level varies from 6m to 10 m during the pre-monsoon season and from 2 to 6 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below(Fig 1 & 2) .

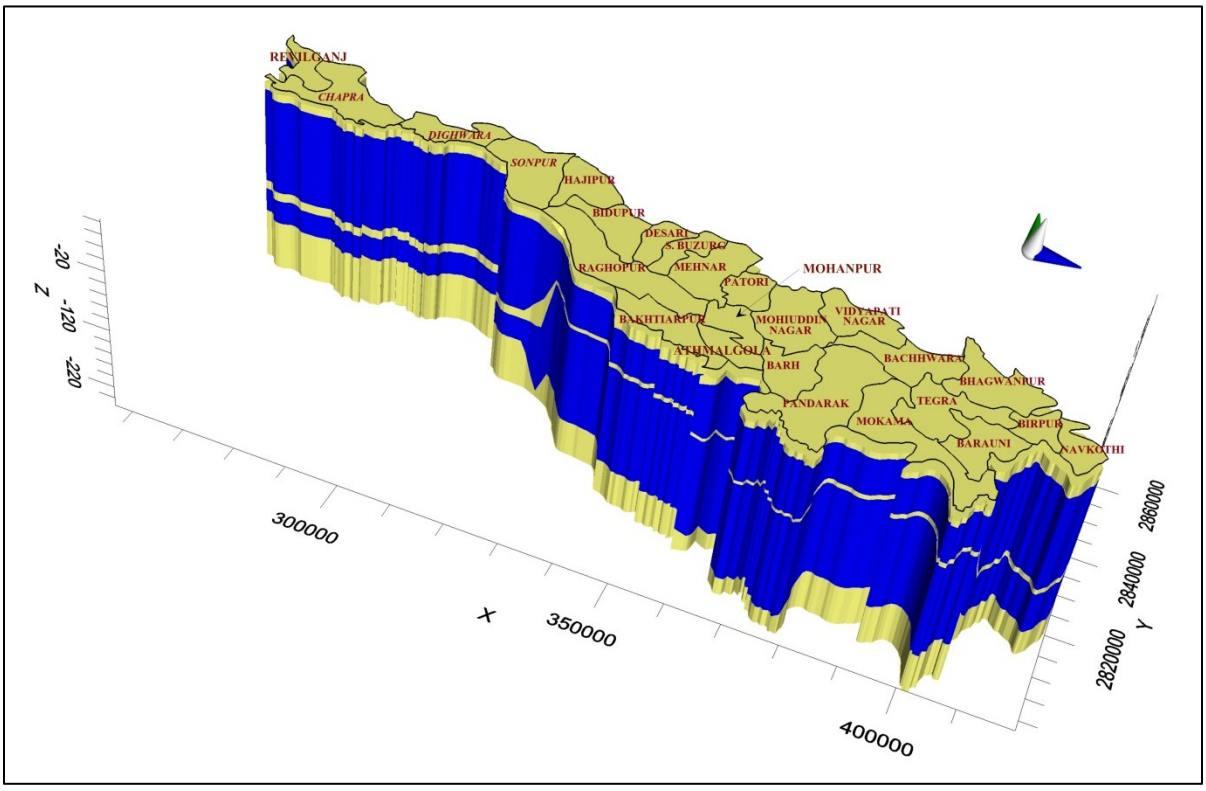


Fig 1:3D View of aquifer disposition

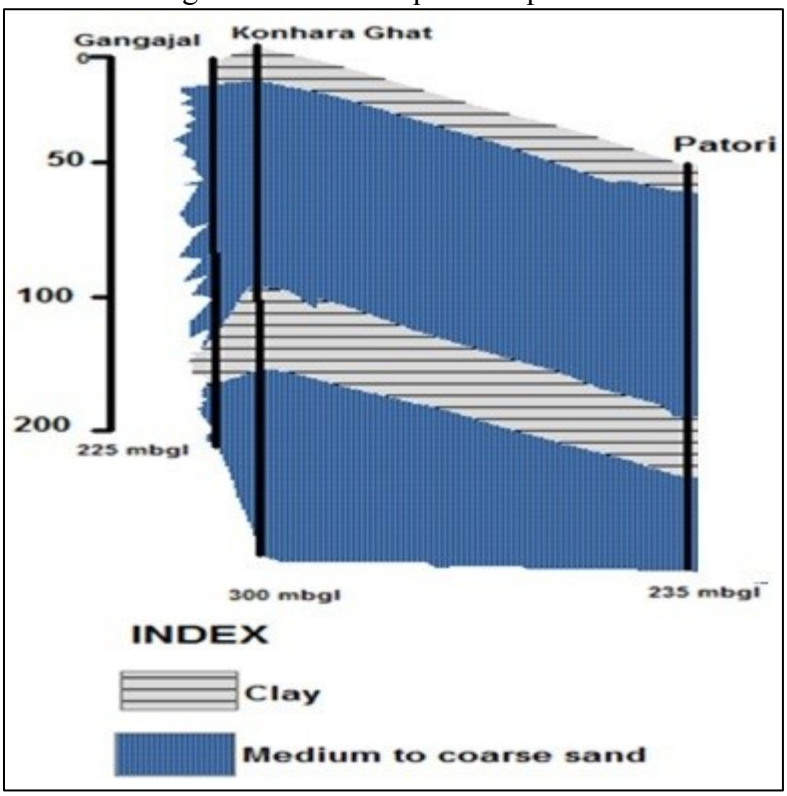
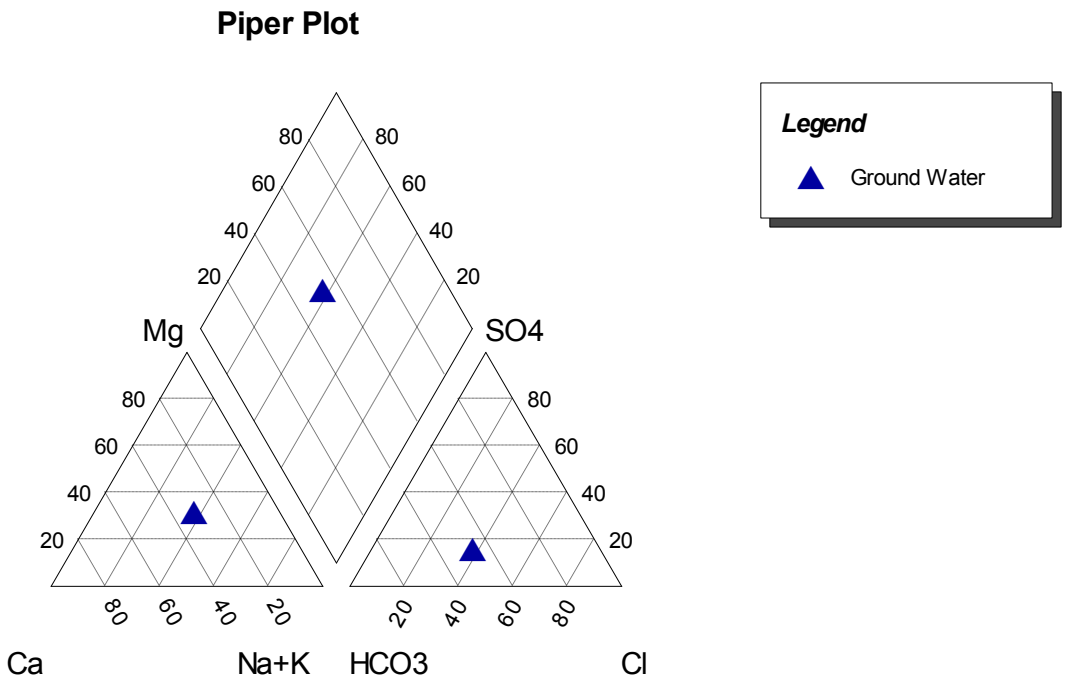


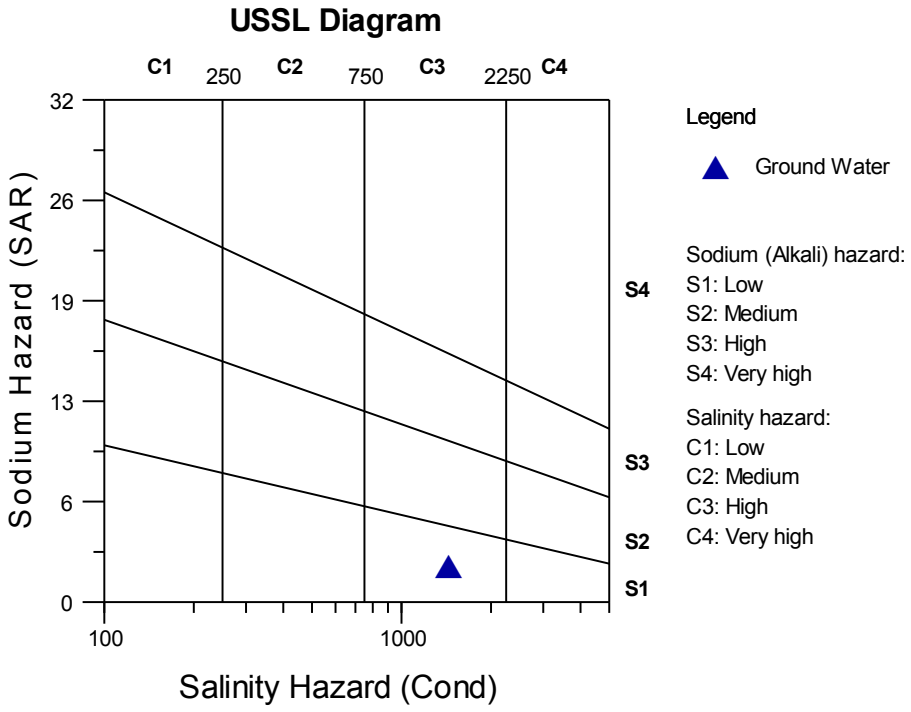
Fig 2: 2D View of aquifer disposition

3. Ground water resource, extraction, contamination and other issues

The overall stage of groundwater development in the Block is 72.9%. Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.
The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination





4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aqufer safe from arsenic contamination.

Annexure I

Dynamic Ground Water Resource Estimation

District	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Developm ent (%)	Categc Safe/S critical al/Ove exploit
Vaishali	Hajipur	2657	421	363	323	3765	377	3389	2221	249	2471	367	800	72.9	Safe

Annexure II

Chemical Analysis of Ground Water Sample

Sample No.	Location	Long	Lat	Block	District	Source	pH	EC	tds	CO3--	HCO3-	Cl-	F	SC
85	Nawada Khurd	85.16733	25.62366	Hajipur	Vaishali	Handpump	8.08	1475	944	0	353.8	173.754	0.78	9

Block wise
Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km^2)
Raghopur

District/ State
VaishaliBihar/

Rainfall

The normal annual rainfall of Vaishali district is 1089mm of which %84occurs during the monsoon season. The normal rainfall during monsoon season is 922mm and during non-monsoon season is 167mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice- Wheat, Rice-Gram, Rice- lentil and Rice- Rai. The soils in this zone are sandy loam, clay loam, laom and clay with pH in the range of 6.8-8. The variation of rainfall in this zone is from 990 mm to 1240 mm and the temperature varies from 37.1 to 7.8˚C.

Ground water resource availability and extraction

The dynamic ground water resource of Raghopur Block has been assessed as 69.92 MCM. The gross ground water draft for all uses stands at 29.54MCM. The stage of Development is 42.2%(Annexure I) .

Water level behavior

The depth to water level varies from 6m to 10 m during the pre-monsoon season and from 2 to 8 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below(Fig 1) .

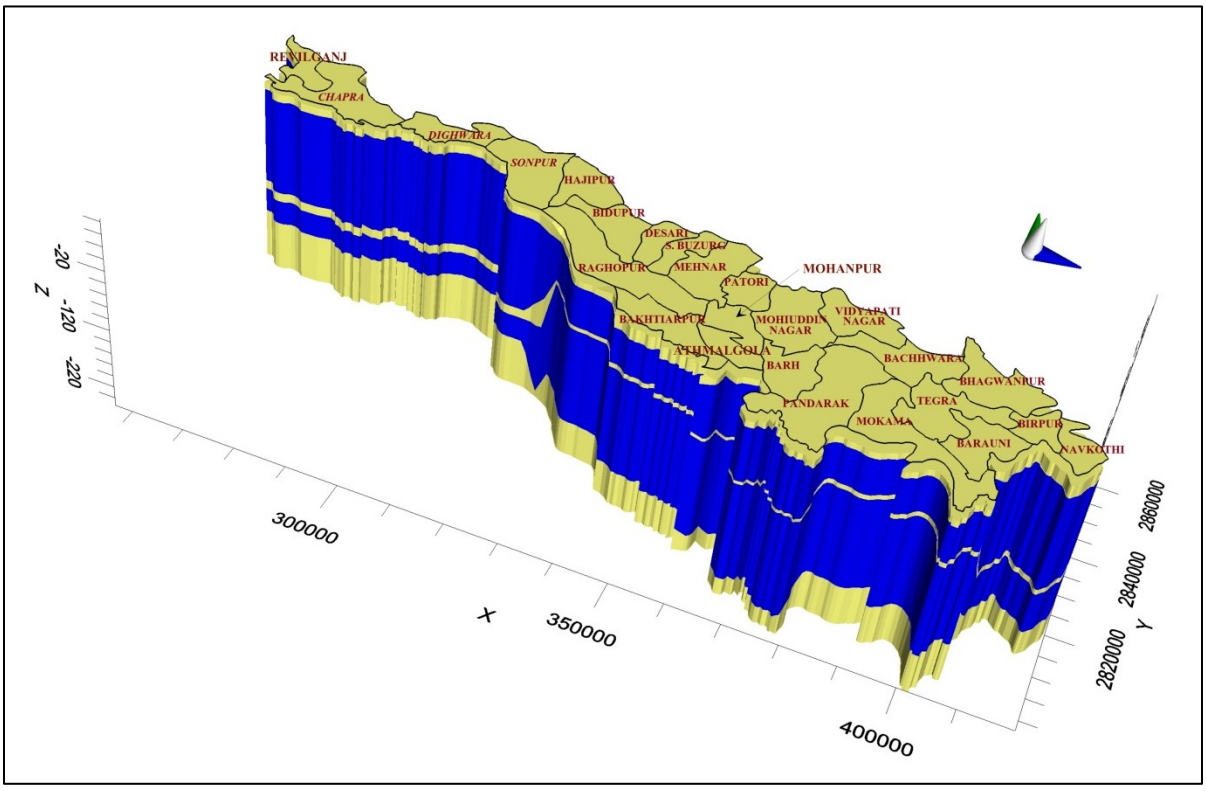


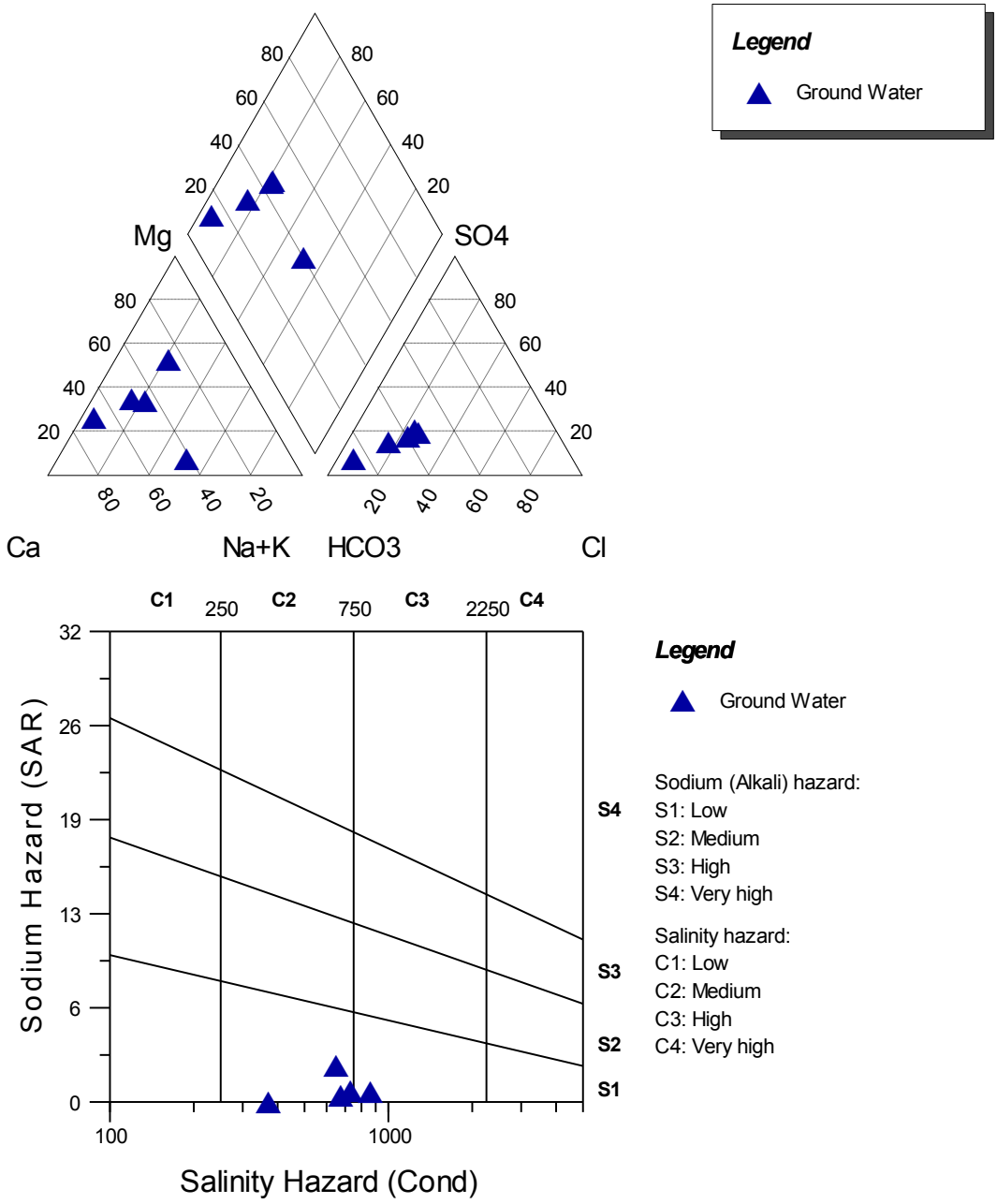
Fig 1:3D View of aquifer disposition

3. Ground water resource, extraction, contamination and other issues

The overall stage of groundwater development in the Block is 42.2%. Thus sufficient scope exists for groundwater development in the Block. Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.

The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination



4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aqufer safe from arsenic contamination.

Annexure I

Dynamic Ground Water Resource Estimation

District	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Development (%)	Categc Safe/Sc critical al/Ove exploit
Vaishali	Raghopur	6068	493	830	378	7769	777	6992	2609	346	2954	509	3875	42.2	Safe

Annexure II

Chemical Analysis of Ground Water Sample

Sample No.	Location	Long	Lat	Block	District	Source	pH	EC	tds	CO3--	HCO3-	Cl-
74	Malikpur(DG)	85.30997	25.5737	Raghopur	Vaishali	Dugwell	7.83	882	564.48	0	237.9	70.92
75	Jagdispur(Handpump)	85.33655	25.5737	Raghopur	Vaishali	Handpump	7.96	664	424.96	0	207.4	49.644
76	Raghopur(Handpump)	85.38222	25.55705	Raghopur	Vaishali	Handpump	8	690	441.6	0	231.8	35.46
77	Raghopur(DW)	85.38222	25.55705	Raghopur	Vaishali	Dugwell	8.18	379	242.56	0	201.3	10.638
78	Medanchowk	85.3242	25.5592	Raghopur	Vaishali	Handpump	8.01	747	478.08	0	250.1	67.374

Block wise
Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km^2)
Desri

District/ State
VaishaliBihar/

Rainfall

The normal annual rainfall of Vaishali district is 1089mm of which %84occurs during the monsoon season. The normal rainfall during monsoon season is 922mm and during non-monsoon season is 167mm.

Agriculture and Irrigation

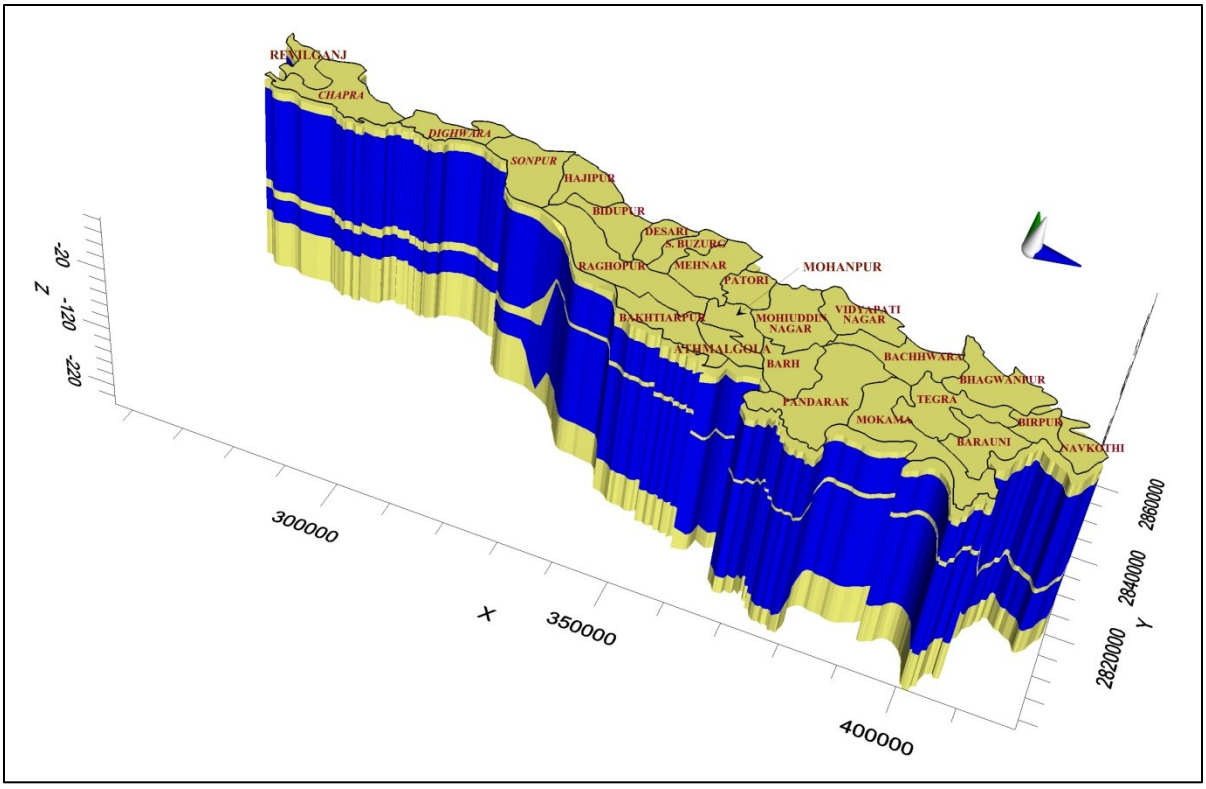
The Block falls in the Agro-climatic Zone I. The cropping sequence followed in Agro-climatic Zone I is Rice- Wheat, Rice- Rai, Rice-Sweet Potato, Rice-Maize, Maize-Wheat, Maize-Sweet Potato, Maize-Rai, Rice-lentil and Rice-linseed. The soils in this zone are sandy loam and loam with pH in the range of 6.5-8.4 The variation of rainfall in this zone is from 1040-1450 mm and the temperature varies from 36.6 to 7.7˚C.

Ground water resource availability and extraction
The dynamic ground water resource of Desri Block has been assessed as 23.29 MCM. The gross ground water draft for all uses stands at 10.99 MCM. The stage of Development is 47.2%(Annexure I) .

Water level behavior
The depth to water level varies from 7.26 m to 7.37 m during the pre-monsoon season and from 4.84 to 5.28 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below.(2 & 1 Fig)



fer dispositionFig 1:3D View of aqui

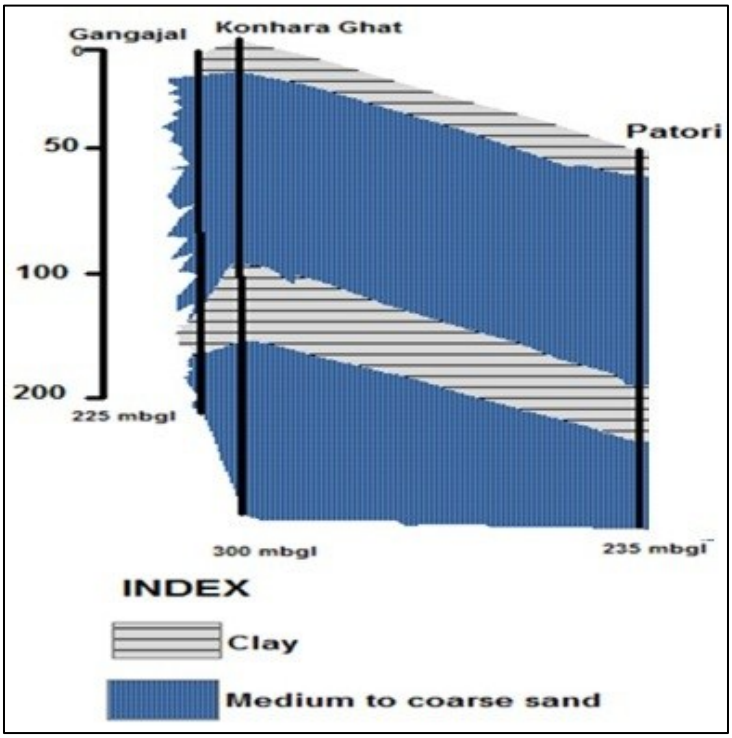


Fig 1 :2D View of aquifer disposition

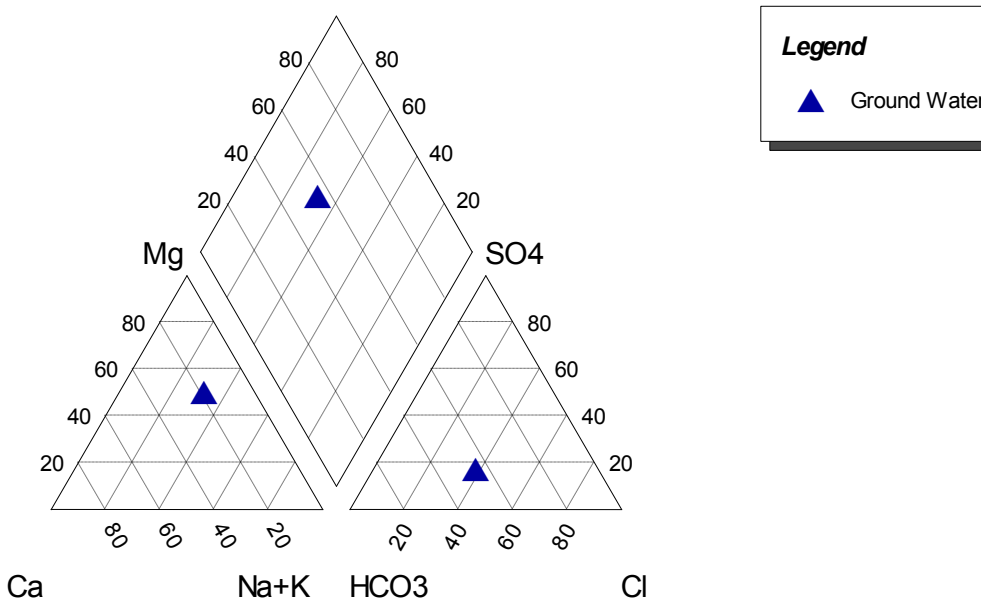
3. Ground water resource, extraction, contamination and other issues

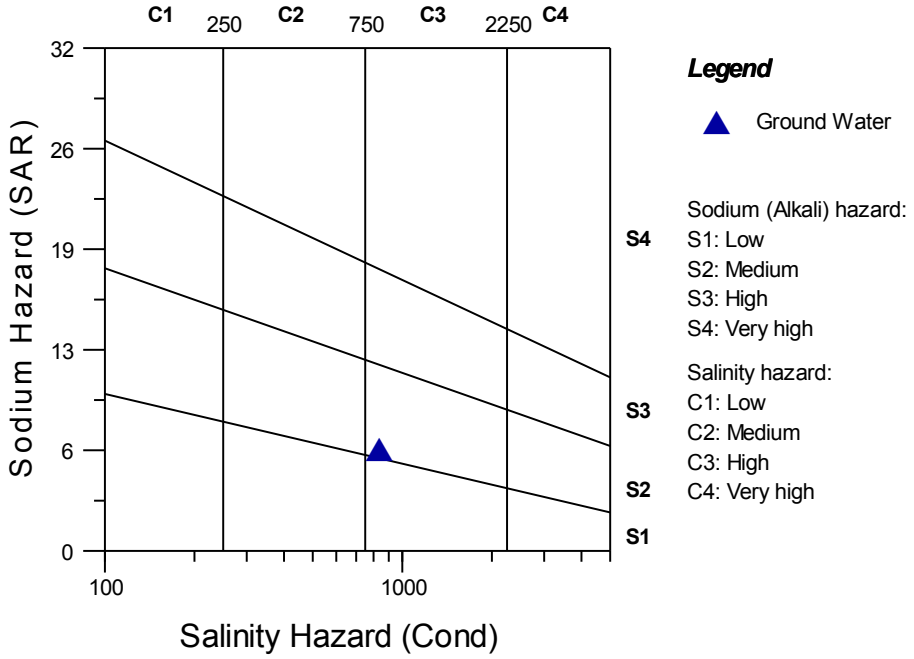
The overall stage of groundwater development in the Block is 47.2%. Thus sufficient scope exists for groundwater development in the Block.

Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit; however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energized extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.

The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination





4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aqufer safe from arsenic contamination.

Annexure- I

Dynamic Ground Water Resource Estimation

District	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Development (%)	Category: Safe/Semi-critical/Critical/Over-exploited
Vaishali	Desri / Premraj	1993	183	619	272	2588	259	2329	962	137	1099	202	1165	47.2	Safe

Annexure II

Chemical Analysis of Ground Water Sample

Sample No.	Location	Long	Lat	Block	District	Source	pH	EC	tds	CO3--	HCO3-	Cl-	F	SO4
87	Khurampur	85.42865	25.6404	Desri	Vaishali	Handpump	8.32	856	547.84	0.2	262.3	53.19	0.87	78

Block wise
Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km^2)
Chapra

District/ State
SaranBihar/

Rainfall

The normal annual rainfall of Saran district is 1068mm of which %86occurs during the monsoon season. The normal rainfall during monsoon season is 929mm and during non-monsoon season is 139mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone I. The cropping sequence followed in Agro-climatic Zone I is Rice- Wheat, Rice- Rai, Rice-Sweet Potato, Rice-Maize, Maize-Wheat, Maize-Sweet Potato, Maize-Rai, Rice-lentil and Rice-linseed. The soils in this zone are sandy loam and loam with pH in the range of 6.5-8.4 The variation of rainfall in this zone is from 1040-1450 mm and the temperature varies from 36.6 to 7.7˚C.

Ground water resource availability and extraction

The dynamic ground water resource of Chapra Block has been assessed as 53.99MCM. The gross ground water draft for all uses stands at 28.02 MCM. The stage of Development is 51.9%(Annexure I).

Water level behavior

The depth to water level varies from 4m to 10 m during the pre-monsoon season and from 2 to 8 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below(Fig 1) .

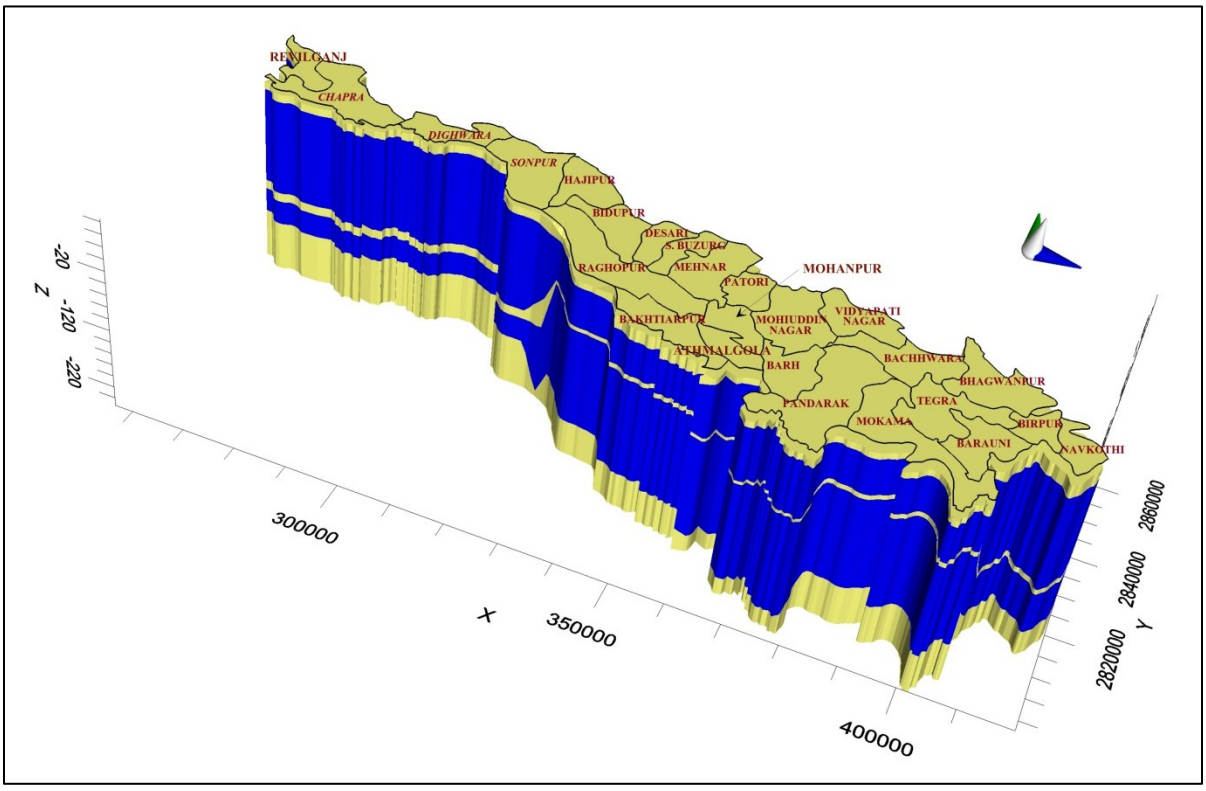


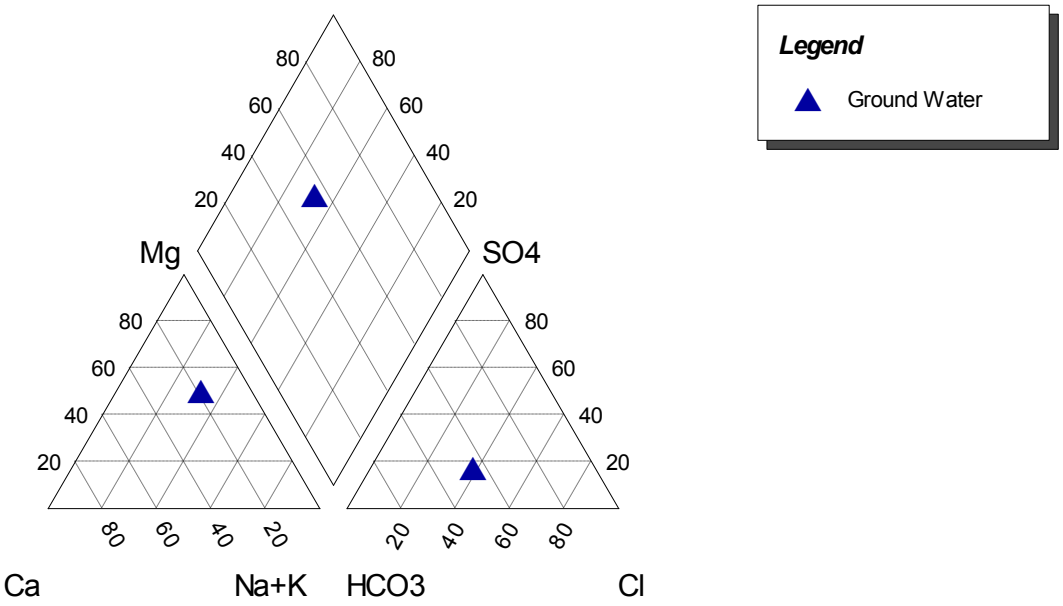
Fig 1:3D View of aquifer disposition

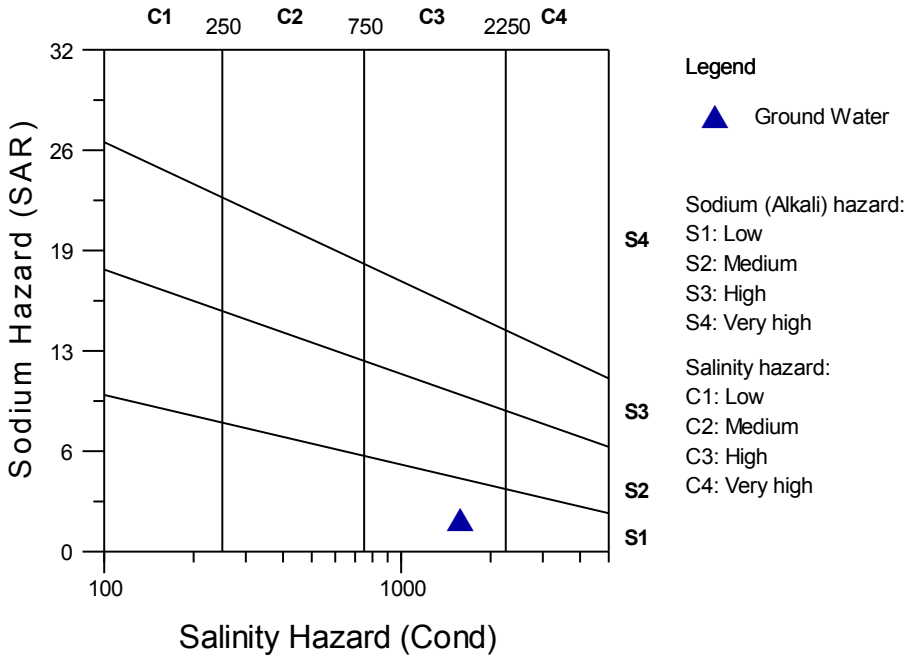
3. Ground water resource, extraction, contamination and other issues

The overall stage of groundwater development in the Block is 51.9%. Thus sufficient scope exists for groundwater development in the Block. Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.

The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination





4. **Ground water resource enhancement**

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. **Demand side interventions**

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aqufer safe from arsenic contamination.

Annexure I

Dynamic Ground Water Resource Estimation

District	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Development (%)	Category: Safe/Semi-critical/Critical/Over-exploited
Saran	Chapra	4387.6	534	569.8	507.7	5998.9	600	5399	2192	610	2802	782	2425	51.9	Safe

Annexure II

Chemical Analysis of Ground Water Sample

Sample No.	Location	Long	Lat	Block	District	Source	pH	EC	tds	CO3--	HCO3-	Cl-	F	SO4
82	Mahadipur	84.84181	25.74023	Chapra	Saran	Handpump	8.04	1618	1035.52	0	402.6	209.214	0.67	129

Block wise
Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km^2)
Dighwara

District/ State
SaranBihar/

Rainfall

The normal annual rainfall of Saran district is 1068mm of which %86occurs during the monsoon season. The normal rainfall during monsoon season is 929mm and during non-monsoon season is 139mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone I. The cropping sequence followed in Agro-climatic Zone I is Rice- Wheat, Rice- Rai, Rice-Sweet Potato, Rice-Maize, Maize-Wheat, Maize-Sweet Potato, Maize-Rai, Rice-lentil and Rice-linseed. The soils in this zone are sandy loam and loam with pH in the range of 6.5-8.4 The variation of rainfall in this zone is from 1040-1450 mm and the temperature varies from 36.6 to 7.7˚C.

Ground water resource availability and extraction

The dynamic ground water resource of Dighwara Block has been assessed as 26.28MCM. The gross ground water draft for all uses stands at 17.59 MCM. The stage of Development is 66.9%(Annexure I) .

Water level behavior

The depth to water level varies from 6m to 10 m during the pre-monsoon season and from 4 to 6 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below(Fig 1) .

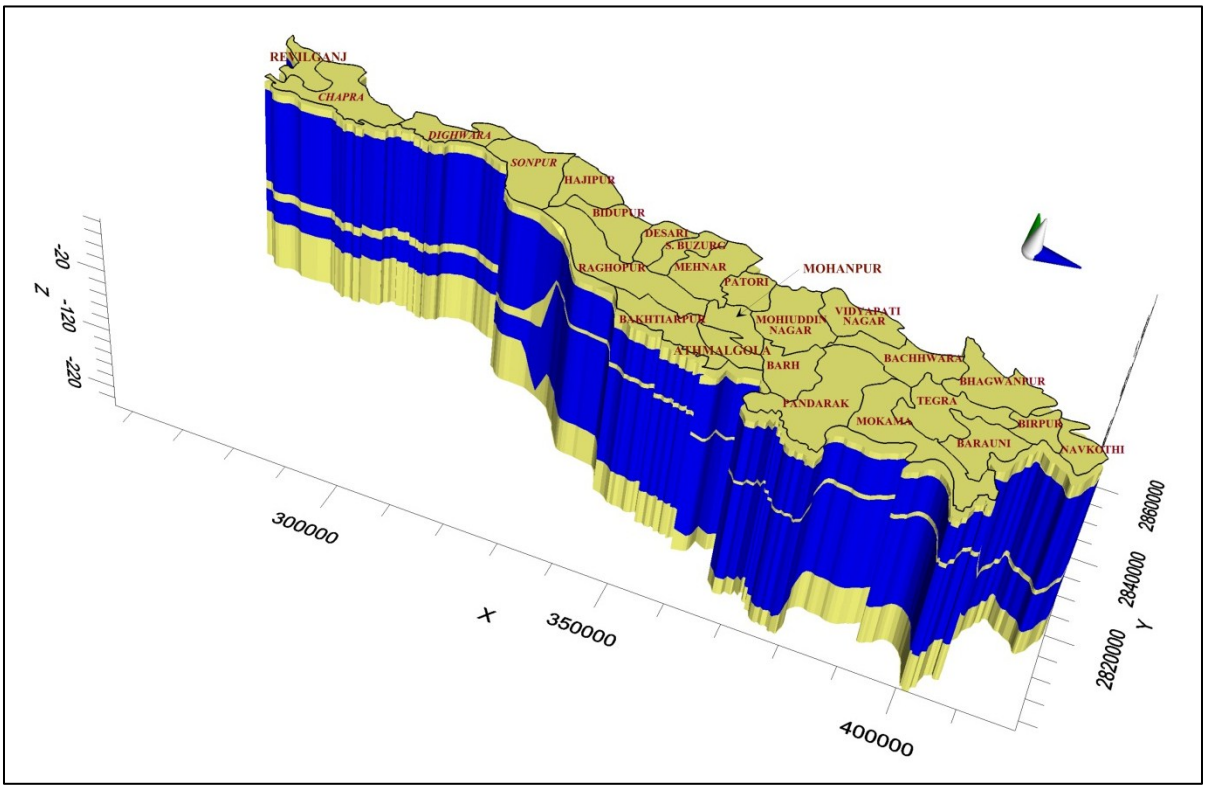


Fig 1:3D View of aquifer disposition

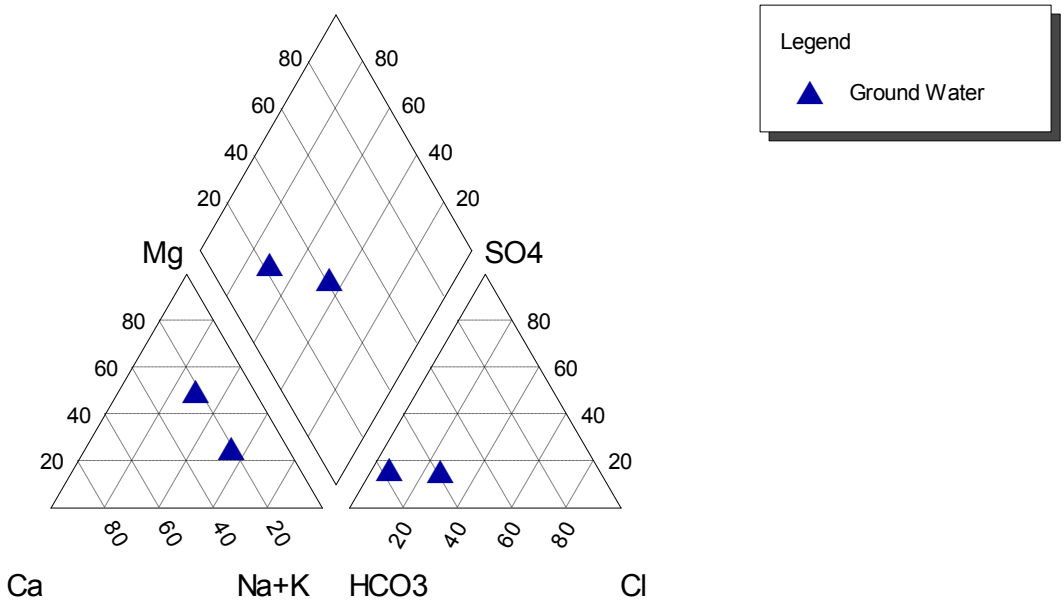
3. Ground water resource, extraction, contamination and other issues

The overall stage of groundwater development in the Block is 66.9%. Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.

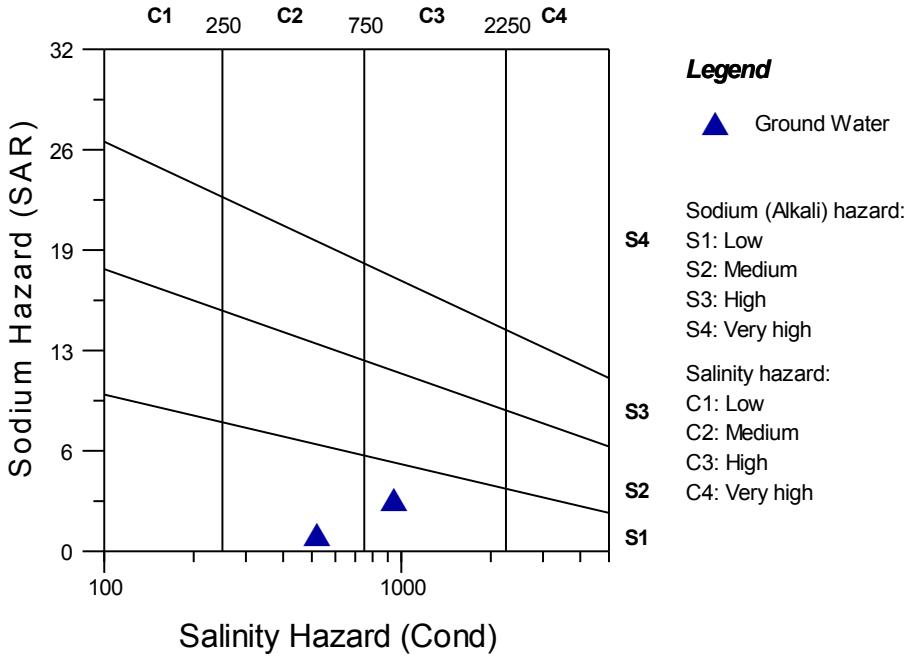
The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination

Piper Plot



USSL Diagram



4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aqufer safe from arsenic contamination.

Annexure I

Dynamic Ground Water Resource Estimation

District	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Developm ent (%)	Categ Safe/ critic al/Ov explo
Saran	Dighwara	2025.8	219	274	247.3	2765.8	138	2628	1472	287	1759	363	793	66.9	Safe

Annexure II

Chemical Analysis of Ground Water Sample

Sample No.	Location	Long	Lat	Block	District	Source	pH	EC	tds	CO3--	HCO3-	Cl-	F	SC
80	Sheetalpur	85.02886	25.75695	Dighwara	Saran	Handpump	8.3	532	340.48	18	244	14.184	0.5	4
81	Syedpur	84.98281	25.75694	Dighwara	Saran	Handpump	8.15	967	618.88	0	286.7	78.012	0.41	6

Block wise
Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km^2)
Revilganj

District/ State
SaranBihar/

Rainfall

The normal annual rainfall of Saran district is 1068mm of which %86occurs during the monsoon season. The normal rainfall during monsoon season is 929mm and during non-monsoon season is 139mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone I. The cropping sequence followed in Agro-climatic Zone I is Rice- Wheat, Rice- Rai, Rice-Sweet Potato, Rice-Maize, Maize-Wheat, Maize-Sweet Potato, Maize-Rai, Rice-lentil and Rice-linseed. The soils in this zone are sandy loam and loam with pH in the range of 6.5-8.4 The variation of rainfall in this zone is from 1040-1450 mm and the temperature varies from 36.6 to 7.7˚C.

Ground water resource availability and extraction

The dynamic ground water resource of Revilganj Block has been assessed as 33.43MCM. The gross ground water draft for all uses stands at 15.66 MCM. The stage of Development is 46.8%(Annexure I)

Water level behavior

The depth to water level varies from 4.89m to 10 m during the pre-monsoon season and from 3.85 to 8 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below(Fig 1) .

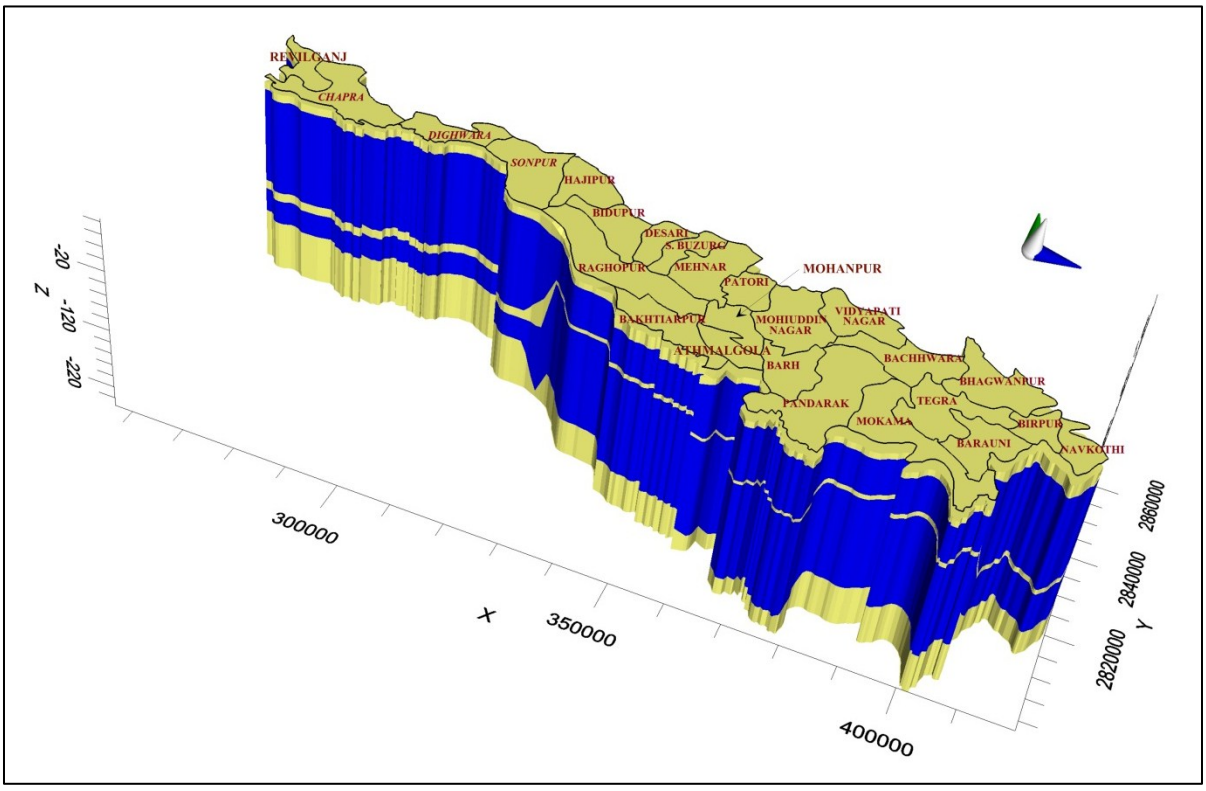


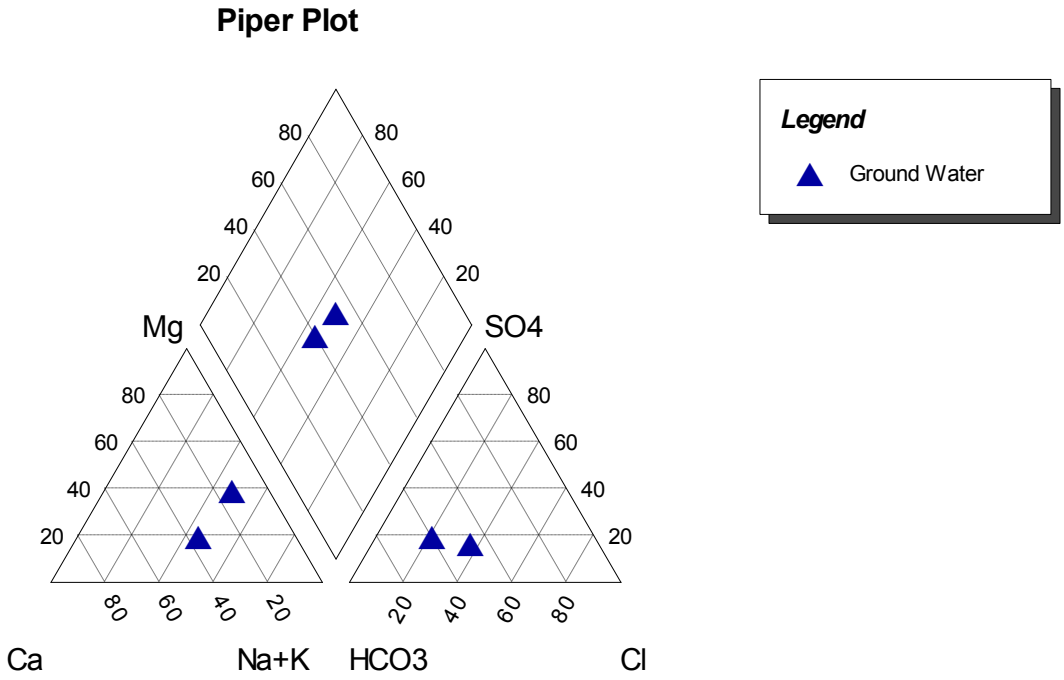
Fig 1:3D View of aquifer disposition

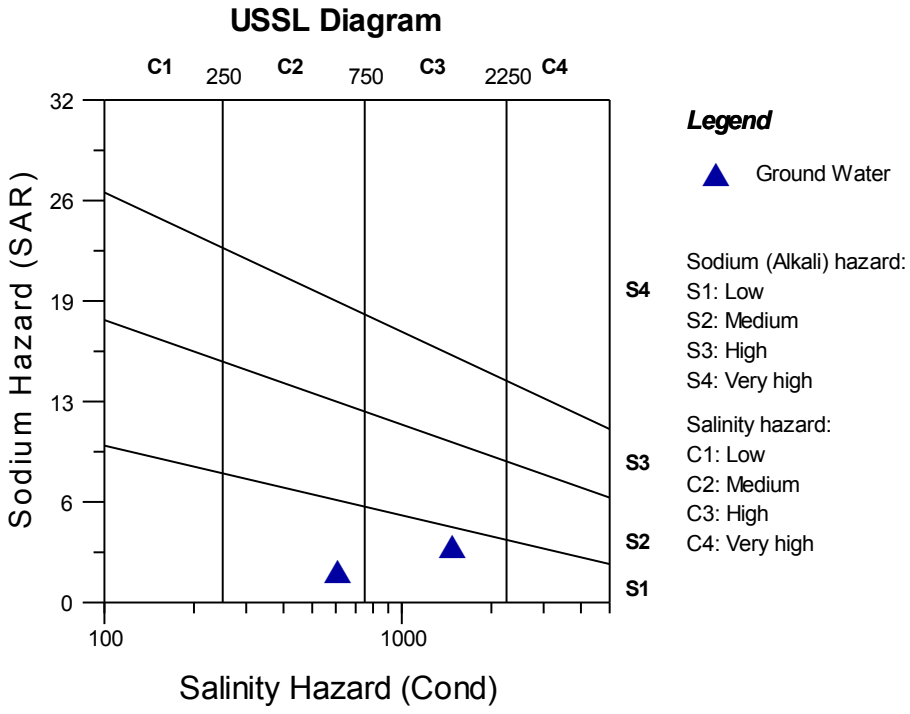
3. Ground water resource, extraction, contamination and other issues

The overall stage of groundwater development in the Block is 46.8%. Thus sufficient scope exists for groundwater development in the Block. Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.

The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination





4. **Ground water resource enhancement**

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. **Demand side interventions**

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aqufer safe from arsenic contamination.

Annexure I

Dynamic Ground Water Resource Estimation

District	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Development (%)	Category: Safe/Semi-critical/Critical/Over-exploited
Saran	Ravelganj	2931.3	189	380.7	213.5	3714.8	371	3343	1275	292	1566	355	1713	46.8	safe

Annexure II

Chemical Analysis of Ground Water Sample

Sample No.	Location	Long	Lat	Block	District	Source	pH	EC	tds	CO3--	HCO3-	Cl-	F	SO4
83	Inai	84.68114	25.79019	Revelganj	Saran	Handpump	8.1	1514	968.96	0	433.1	205.668	0.6	12
84	Nagri gaon	84.77317	25.80688	Revelganj	Saran	Handpump	8.04	622	398.08	0	195.2	42.552	0.4	51

Block wise
Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km^2)
Sonpur

District/ State
Saran/Bihar

Rainfall

The normal annual rainfall of Saran district is 1068mm of which %86occurs during the monsoon season. The normal rainfall during monsoon season is 929mm and during non-monsoon season is 139mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone I. The cropping sequence followed in Agro-climatic Zone I is Rice- Wheat, Rice- Rai, Rice-Sweet Potato, Rice-Maize, Maize-Wheat, Maize-Sweet Potato, Maize-Rai, Rice-lentil and Rice-linseed. The soils in this zone are sandy loam and loam with pH in the range of 6.5-8.4 The variation of rainfall in this zone is from 1040-1450 mm and the temperature varies from 36.6 to 7.7˚C.

Ground water resource availability and extraction

The dynamic ground water resource of Sonpur Block has been assessed as 39.26 MCM. The gross ground water draft for all uses stands at 15.64 MCM. The stage of Development is 39.8%(Annexure I) .

Water level behavior

The depth to water level varies from 4m to 8 m during the pre-monsoon season and from 2 to 6 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below(Fig 1 & 2) .

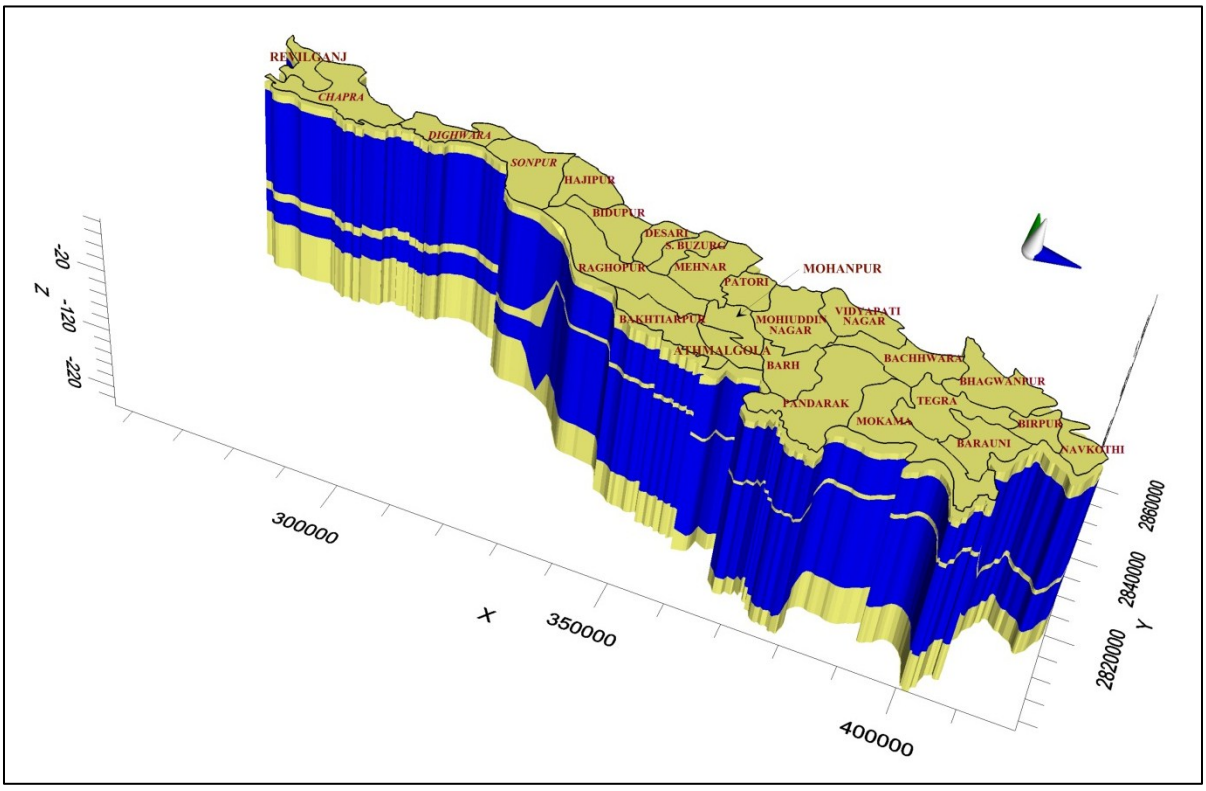


Fig 1:3D View of aquifer disposition

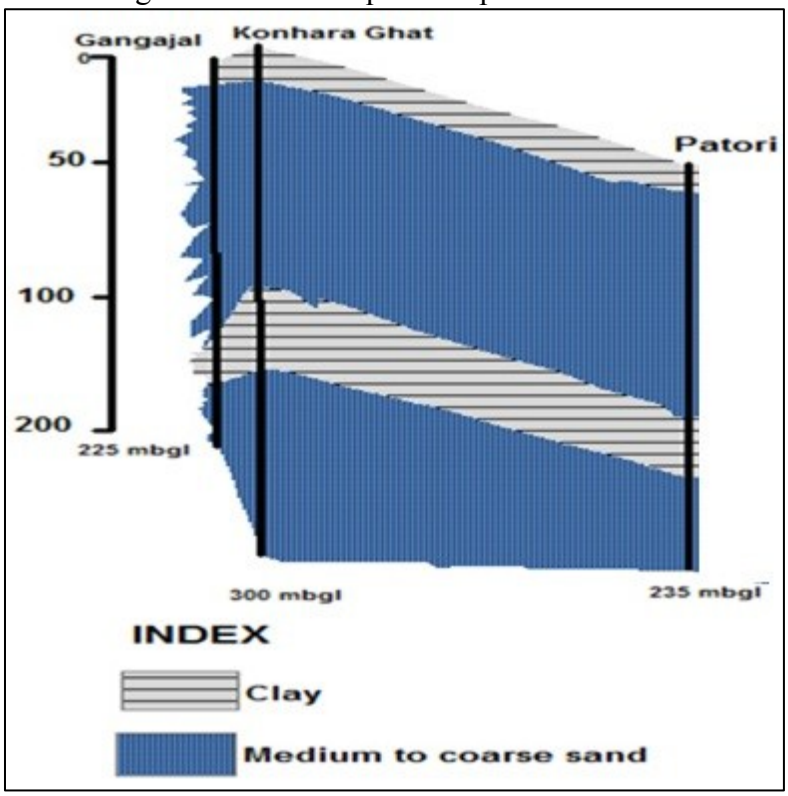


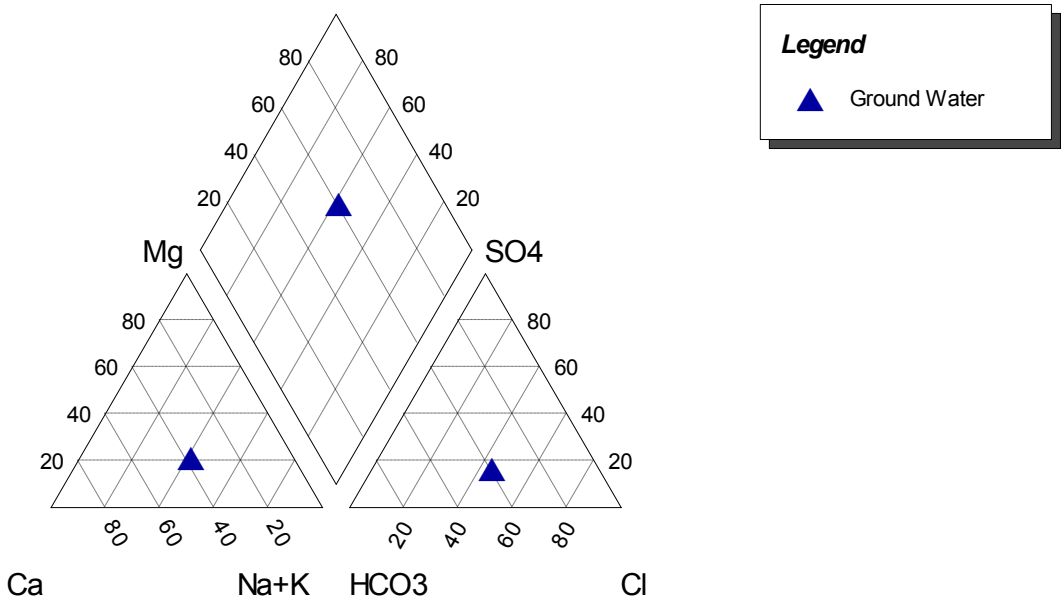
Fig 2: 2D View of aquifer disposition

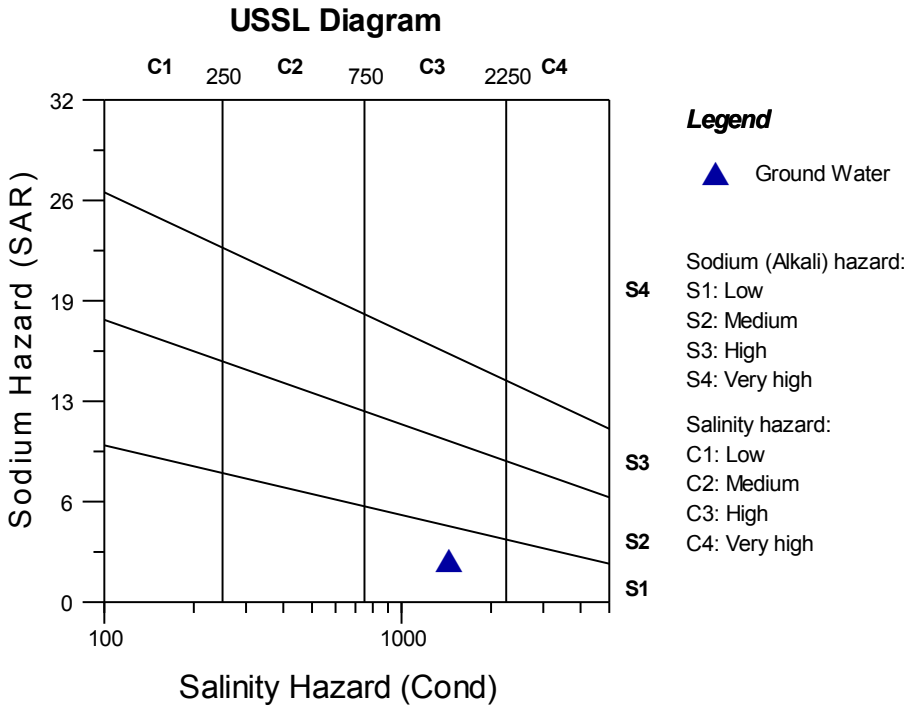
3. Ground water resource, extraction, contamination and other issues

The overall stage of groundwater development in the Block is 39.8%. Thus sufficient scope exists for groundwater development in the Block. Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.

The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination





4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aqufer safe from arsenic contamination.

Annexure I

Dynamic Ground Water Resource Estimation

District	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Developm ent (%)	Categ Safe/ critic al/Ov explo
Saran	Sonepur	3283.5	156	517.5	175.9	4132.9	207	3926	1050	513	1564	683	2192	39.8	Safe

Annexure II

Chemical Analysis of Ground Water Sample

Sample No.	Location	Long	Lat	Block	District	Source	pH	EC	tds	CO3--	HCO3-	Cl-	F	S
79	Govindchowk	85.18478	25.74033	Sonepur	Saran	Handpump	7.98	1478	945.92	0	274.5	191.484	0.62	

Block wise
Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km^2)
Mohanpur

District/ State
SamastipurBihar/

Rainfall

The normal annual rainfall of Samastipurdistrict is 1142mm of which %84 occurs during the monsoon season. The normal rainfall during monsoon season is 964 mm and during non-monsoon season is 178mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone I. The cropping sequence followed in Agro-climatic Zone I is Rice- Wheat, Rice- Rai, Rice-Sweet Potato, Rice-Maize, Maize-Wheat, Maize-Sweet Potato, Maize-Rai, Rice-lentil and Rice-linseed. The soils in this zone are sandy loam and loam with pH in the range of 6.5-8.4 The variation of rainfall in this zone is from 1040-1450 mm and the temperature varies from 36.6 to 7.7˚C.

Ground water resource availability and extraction

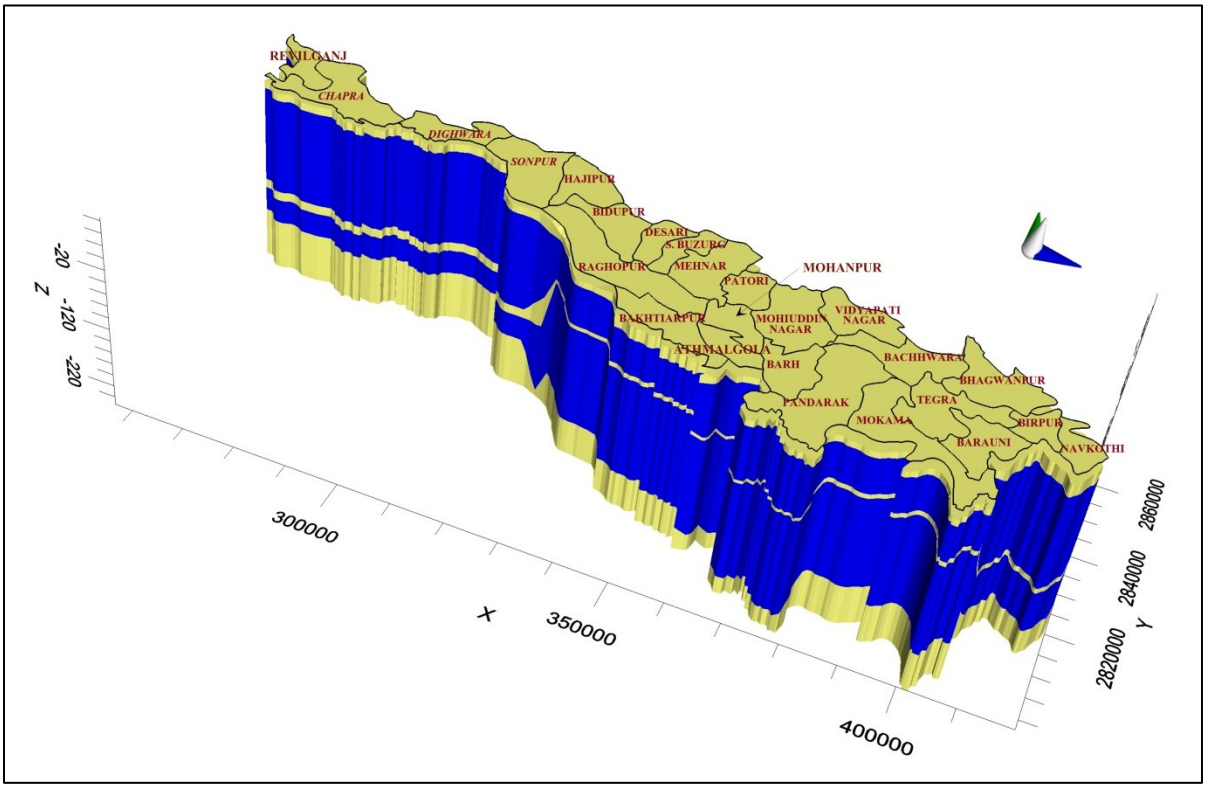
The dynamic ground water resource of Samastipur Block has been assessed as 23.66MCM. The gross ground water draft for all uses stands at 7.93 MCM. The stage of Development is 33.5%(Annexure I) .

Water level behavior

The depth to water level varies from 6m to 8 m during the pre-monsoon season and from 8to 10 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below.



nFig 1:3D View of aquifer dispositio

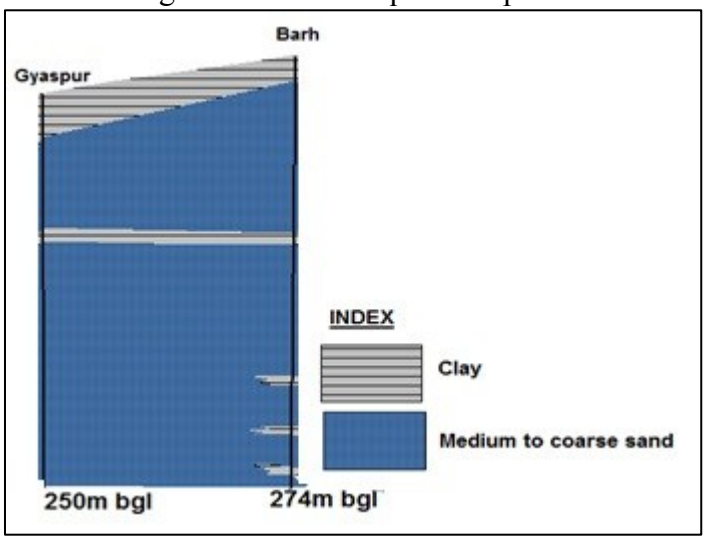


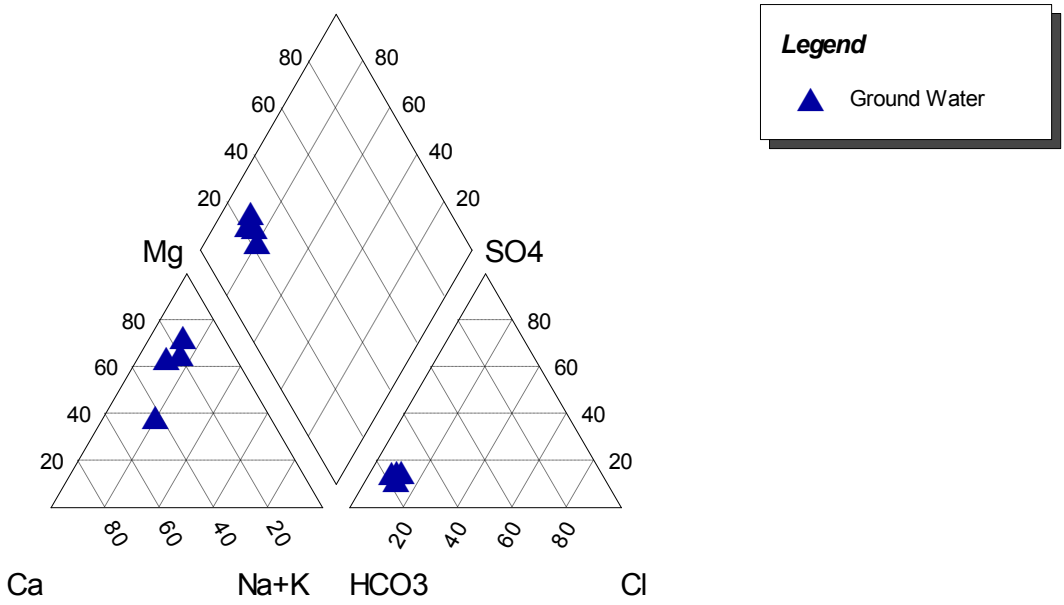
Fig 2: 2D View of aquifer disposition

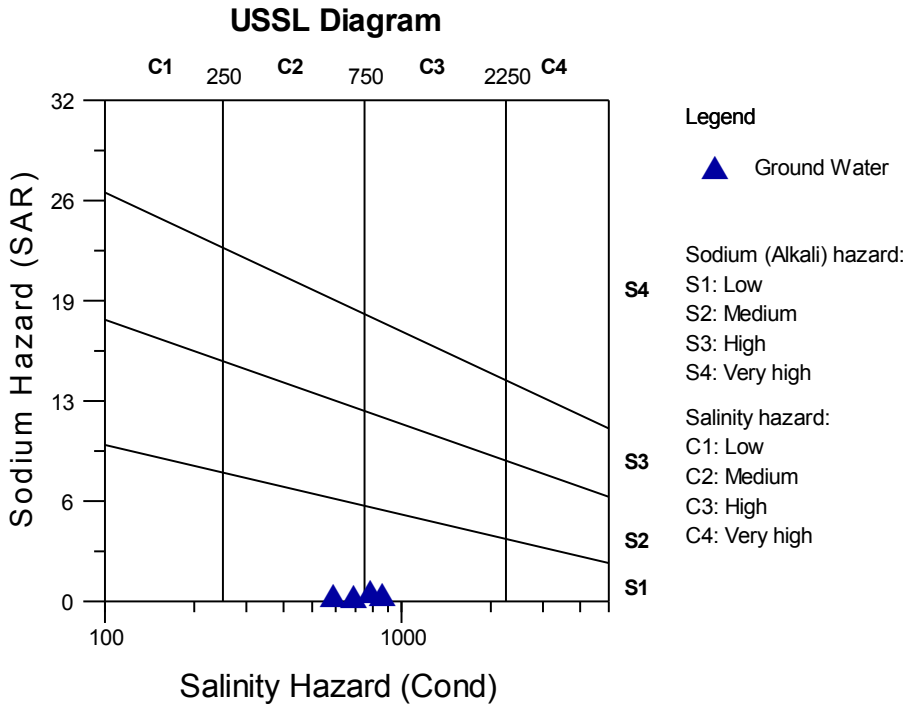
3. Ground water resource, extraction, contamination and other issues

The overall stage of groundwater development in the Block is 33.5%. Thus sufficient scope exists for groundwater development in the Block. Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water

supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.
The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination





4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aqufer safe from arsenic contamination.

Annexure I

Dynamic Ground Water Resource Estimation

District	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Development (%)	Cate Safe criti ical/ expl
Samastipur	Mohanpur	1949	120	333	89	2491	125	2366	621	171	793	272	1473	33.5	safe

Annexure II

Chemical Analysis of Ground Water Sample

Sample No.	Location	Long	Lat	Block	District	Source	pH	EC	tds	CO3--	HCO3-	Cl^-
1	Gadi Mohanpur	85.5718	25.56817	Mohanpur	Samastipur	Handpump	7.37	602	385.28	0	244	21
2	Mohanpur College Chauk	85.5839	25.56272	Mohanpur	Samastipur	Handpump	7.34	880	563.2	0	366	35
3	Bhagara	85.5948	25.55994	Mohanpur	Samastipur	Handpump	7.27	803	513.92	0	293	21
4	Bilgama	85.6139	25.56397	Mohanpur	Samastipur	Handpump	7.35	706	451.84	0	311	32

Block wise
Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km^2)
Mohiuddin Nagar

District/ State
SamastipurBihar/

Rainfall

The normal annual rainfall of Samastipurdistrict is 1142mm of which %84 occurs during the monsoon season. The normal rainfall during monsoon season is 964 mm and during non-monsoon season is 178mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone I. The cropping sequence followed in Agro-climatic Zone I is Rice- Wheat, Rice- Rai, Rice-Sweet Potato, Rice-Maize, Maize-Wheat, Maize-Sweet Potato, Maize-Rai, Rice-lentil and Rice-linseed. The soils in this zone are sandy loam and loam with pH in the range of 6.5-8.4 The variation of rainfall in this zone is from 1040-1450 mm and the temperature varies from 36.6 to 7.7˚C.

Ground water resource availability and extraction

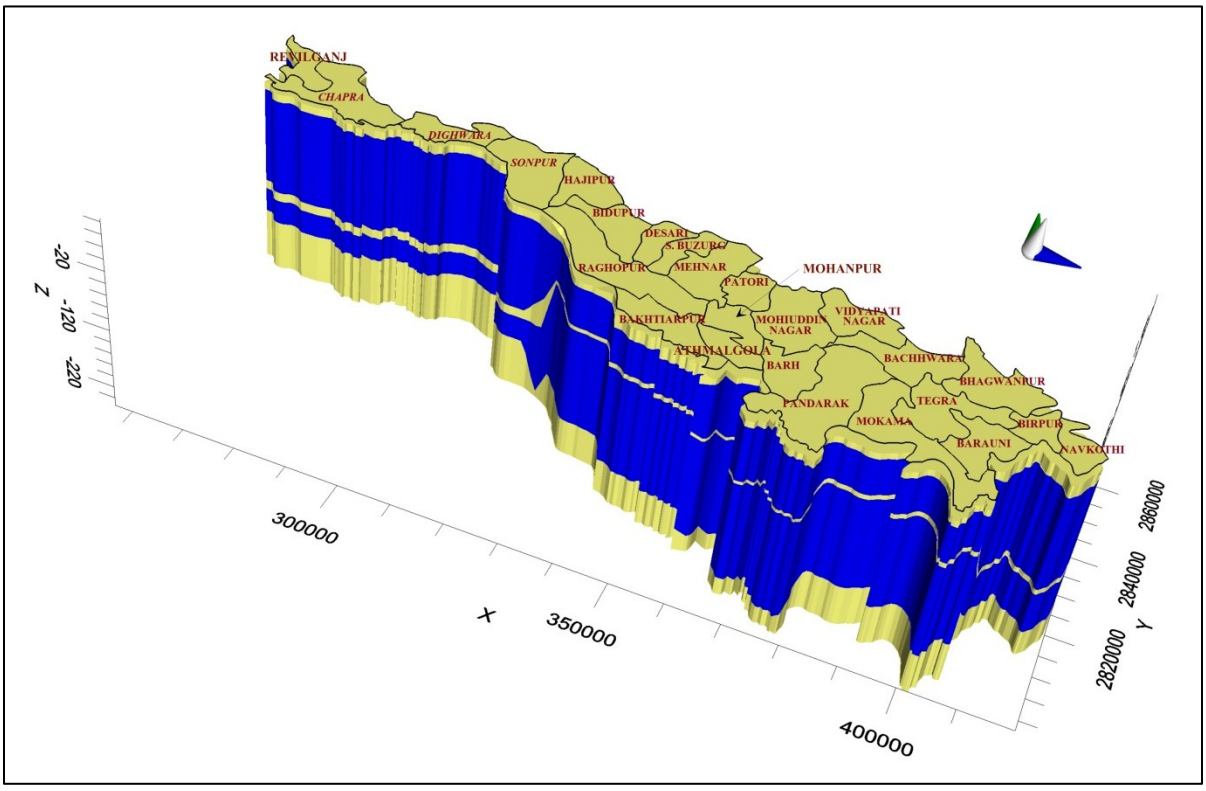
The dynamic ground water resource of Mahiuddin Nagar Block has been assessed as 42.77 MCM. The gross ground water draft for all uses stands at 20.96 MCM. The stage of Development is 49%(Annexure I) .

Water level behavior

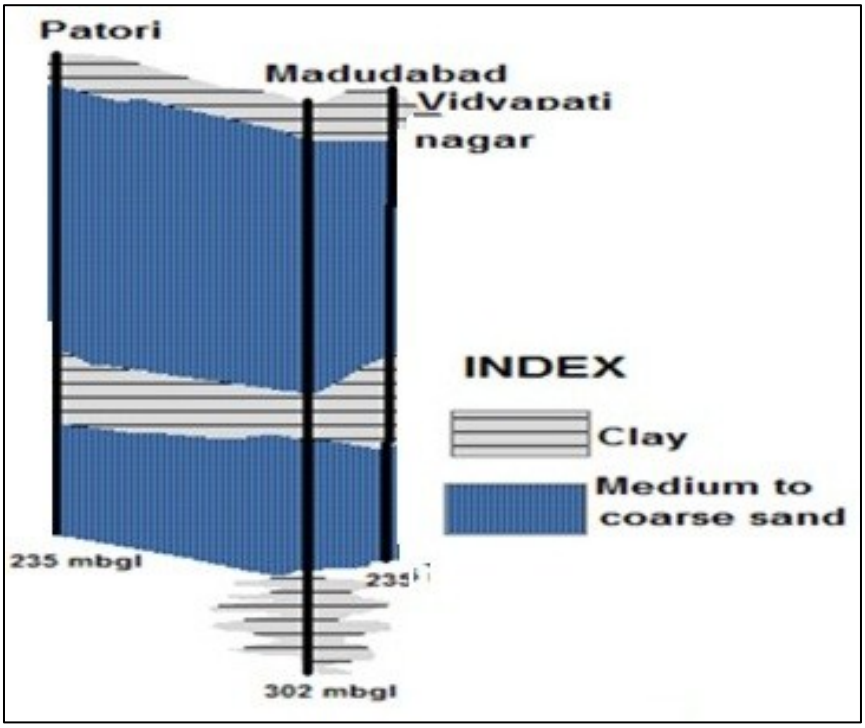
The depth to water level varies from 5m to 10 m during the pre-monsoon season and from 2 to 8 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below(2 & 1 Fig)



D View of aquifer disposition3 :1 Fig



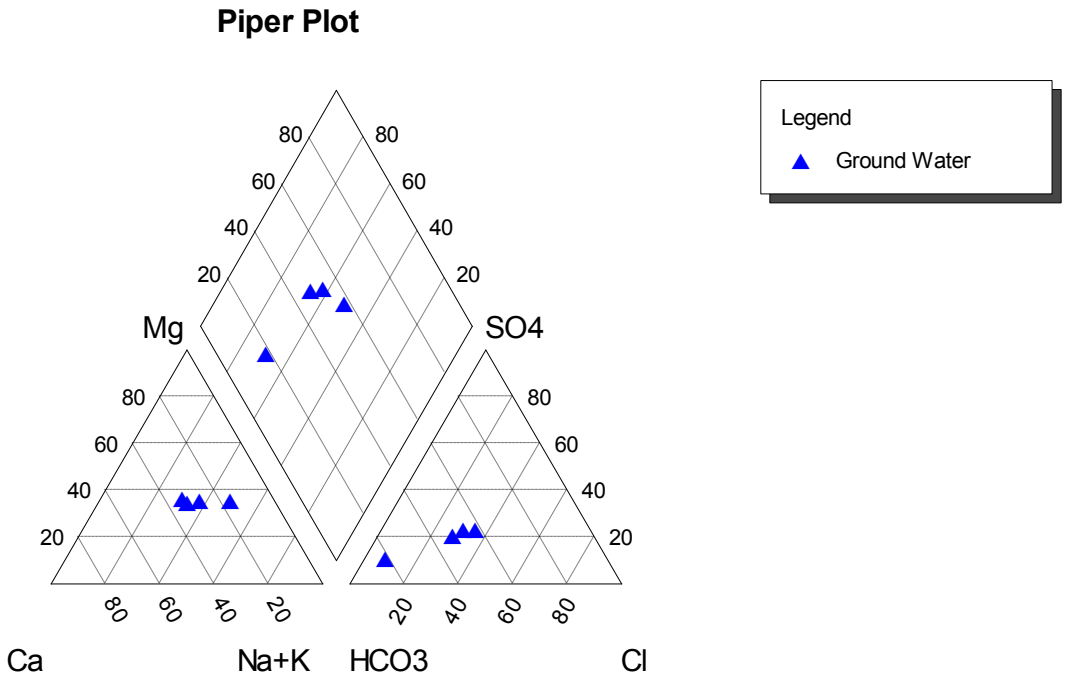
3. Ground water resource, extraction, contamination and other issues

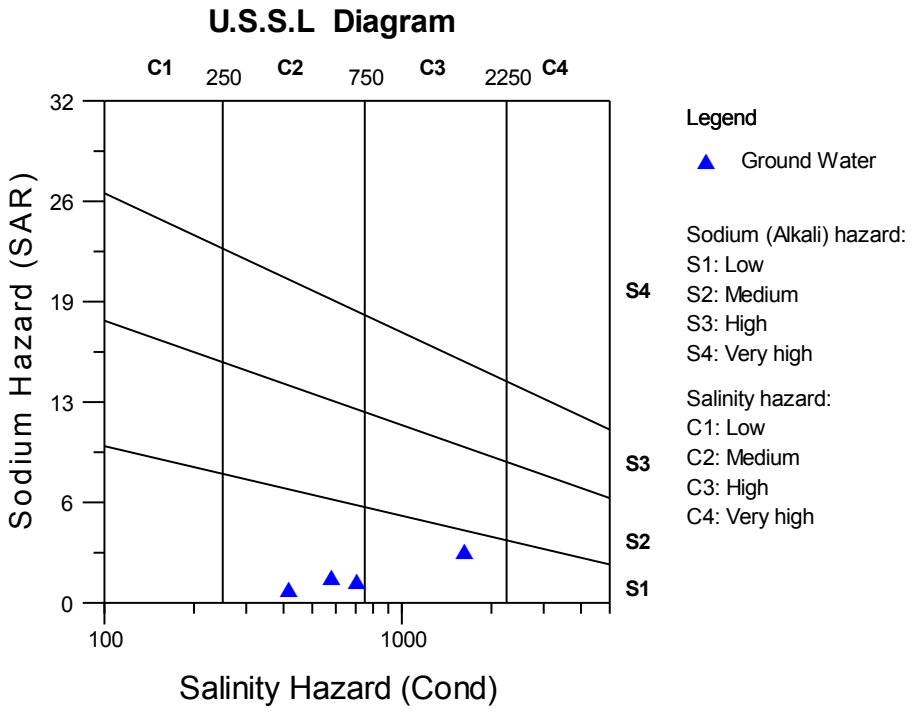
The overall stage of groundwater development in the Block is 49%. Thus sufficient scope exists for groundwater development in the Block.

Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.

The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination





4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aqufer safe from arsenic contamination.

Annexure I

Dynamic Ground Water Resource Estimation

District	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Developm ent (%)	Cate Safe criti al/C expl
Samastipur	Mohiuddin-nagar	3385	336	533	248	4502	225	4277	1739	358	2096	637	1901	49	Safe

Annexure II

Chemical Analysis of Ground Water Sample

sl no	Location	Block	well no	type of well	E.C.	TDS	Hardness	ph	HCO3(mg/l)	Cl(mg/l)	SO4(mg/l)	F(mg/l)	Ca
22	Andore	M.Nagar	Rs-34	Dw	423	356.61	170	8.35	225.7	14.2	23.3	0.21	
23	Rajajan	M.Nagar	Rs-36	DW	718	469.9	130	7.9	207.4	67.4	66	0.5	
32	Madudabad	M.Nagar	Rs-56	DW	1651	1078.3	400	7.65	396.5	198.8	173.8	0.2	
24	Lagunia	M.Nagar	Rs-41	DW	590	430.65	210	8.21	170.8	67.5	67.5	0.25	